ANUARY 1, 1919 PRICE 25 CENTS

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AERONAUTICAL ENGINEERING

A Four-Engined Super Handley Page of 126 ft. Span
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VOLUME V
Number 11

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AIR TRANSPORT NUMBER

ORVILLE WRIGHT ON FUTURE OF CIVIL FLYING
THE MARTIN TWIN-ENGINE BOMBER
AIR TRANSPORT AND THE AIRCRAFT INDUSTRY
THE CURTISS MODEL K, 12 CYLINDER ENGINE
FUTURE OF THE HELIUM AIRSHIP
THE NAVAL FLYING BOAT NC-1

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER-MOFFAT CO., INC.
120 WEST 32nd ST. NEW YORK

Entered as second-class matter, August 2, 1916, at the
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(83)

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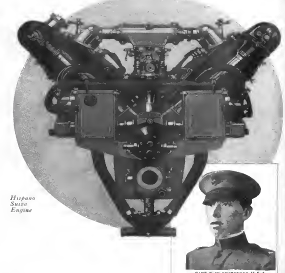

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During 1919 AVIATION will be an important factor through its vigorous editorial policy in developing and promoting AMERICAN AERONAUTICS.

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JANUARY 1, 1919 — VOL. V. NO. 11

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THE GARDNER - MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET, NEW YORK
WASHINGTON OFFICE EVENING STAR BUILDING

SUBSCRIPTION PRICE THREE DOLLARS PER YEAR SINGLE COPIES TWENTY-FIVE CENTS CANADA THREE AND A HALF DOLLARS FOREIGN FOUR DOLLARS A YEAR

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH FORMS CLOSE FIVE DAYS PREVIOUSLY ENTERED AS SECOND-CLASS MATTER, AUGUST 3 1916 AT THE POST OFFICE AT NEW YORK N Y UNDER ACT OF MARCH 3 1879

W. D MOFFAT, PRESIDENT
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AVIATION AND AERONAUTICAL ENGINEERING

LADISLAS D'ORCY, ASSOCIATE EDITOR
GEORGE NEWBOLD, BUSINESS MANAGER

Vol. V January 1, 1919 No 11

THERE has come out of the war a definite conviction regarding the commercial future of the airplane which is shared by practically all the civilized people in the world This idea of the future role of heavier-than-air craft is centered upon the industrial possibilities of the air From the dreamer who predicts all manner of fantastic employment of airplanes to the aeronautical engineer who must be convinced every step of the way, all thoughtful persons who have witnessed the scientific achievements of the last two decades are certain regarding the future possibilities of air travel and transportation

It is only necessary to remember how recently the electric light was given its first commercial trial in a Boston theatre and to trace the rapid expansion of the telephone and telegraph from their primitive beginnings, to see that those far sighted men who backed an idea which was fundamentally sound and persevered have become commercial captains of industry in their respective fields It seems only yesterday that the motor vehicles and wireless were in the crudest commercial stages All that has been needed has been optimistic confidence to bring these inventions to a state of commercial development

The war has given thousands of men of all professions an insight into aeronautics and all are enthusiastic over its many possibilities While the development of types of machines has of necessity been along military and naval lines and production methods have prevented the introduction of radical ideas yet the constant contact of so many ingenious minds with the theory and practical application of aircraft has probably put innumerable ideas for progress into the heads of all who have had to do with air programs of the various countries

And it is from these ideas that will come the machines which will solve some of the problems that will have to be met before the airplane reaches its goal of commercial excellence and can compete with existing facilities. These advancements will mean improvements in the matter of safety weight per horsepower, and parking space required for commercial airplanes

The attitude of the Government during the war has prevented all commercial flying The issuing of individual licenses should be commenced at once and the freest encouragement given to all who desire to enter the aeronautical field as sportsmen or to those seeking an industrial opportunity

The commercial side of aeronautics is now dependent on the coming of the far sighted industrial leaders, who like the late James J Hill, will lay out an empire and resolve to be its masters regardless of the difficulties Mr Hill and other early railroad pioneers were thought to be headed for financial ruin when they embarked on projects of transportation through unsettled western lands, but their judgment and the ultimate success of their extensions never could be shaken. To the men who resolve to make the empire of the air theirs, and who will insist on breaking down all bars to success, will come the everlasting credit due great commercial leaders of the century

Airplane Progress in the War

The progress of Naval and Military Aeronautics during the war has been stupendous Further progress in the same direction is perfectly assured, although achievements will be secured only by serious effort in engineering, in the development of armament, special sighting and other military devices That there will be a continuation of such effort can scarcely be doubted The more interesting problem is the design of airplanes which will meet the needs of commerce

It is interesting to take brief stock of what the war has and has not done for the airplane from this point of view. It has only given us a machine of neutral stability and moderately slow landing qualities, not fully meeting the requirements of a commercial vehicle. On these two points the commercial designer faces difficult, but not insoluble problems But this is almost all there is on the debit side On the credit side we have the streamline wire, developed to a point of perfect reliability, an achievement helping us to cut down the rightly termed parasite resistance, and increasing speed for the same power by at least five per cent We have engines of four or five times the power of the pre-war engine, weighing not more than two pounds per horse power, as compared with the four or five pounds of pre war times, yet having greater reliability and flexibility We have aerofoils of far better aerodynamic qualities, attaining possibly the limit of efficiency The mass of unnecessarily exposed control cables has disappeared within the wing and the body Propellers are no longer a hit or miss proposition and the most valuable qualities of durability and weatherproofing have been attained The structural strength of wings, bodies and control surfaces has been considerably increased without addition in weight, new materials have been brought into use dopes can be applied without the wholesale poisoning of the workmen All this the commercial designer owes to intense war activities

It is a valuable heritage, which would only have been earned in twice the years in peace time With all this valuable progress achieved, it becomes an easy though still interesting engineering problem to utilize the airplane for the multifarious activities of peace

The Future of Civil Flying

By Orville Wright

Fifteen years have passed on Dec 17, 1918, since Orville Wright and his late brother Wilbur startled an incredulous world with the announcement that they had achieved the conquest of the air by the invention of a heavier-than-air craft, the airplane. That forever memorable day which, for the first time in the history of the world, saw a machine heavier than air, and carrying a human pilot, raise itself from the ground, fly under full control, and land again at the will of the pilot, today appears almost shrouded in the dim past of history so common has the sight of an airplane become to the public. The fact that the airplane proved one of the most effectual weapons in the defense of Civilization should compensate for the sorrow that may be felt at the airplane being used for destruction before it could demonstrate its usefulness in peaceful pursuits.

Now, that the din of arms has ceased and a rightful peace is soon to be established, the airplane promises to soon enter a new era of its development, which will be characterized by the advent of commercial aviation and civil flying. The following article, written especially for AVIATION AND AERONAUTICAL ENGINEERING, *is of exceptional interest as expressing the views the Dean of Aviation holds with respect to the principal problems which confront the establishment of civil aeronautics.*

Although it is now fifteen years since the first flight was made with a heavier-than-air machine, the use of the airplane for commerce and sport has developed but little. This failure has been accounted for in several ways. It has been said that the expense of owning and maintaining a flying machine is too great. This possibly has been true so far as the commercial use was concerned, but it certainly does not account for the small amount of use for sport. While the first cost of an airplane is slightly greater, and its upkeep a good deal greater, than that of the automobile, yet its cost in both of these respects is very much less than that of a yacht. It really is no greater than the expense of a comparatively small motor boat. We have thousands of young men in the country who easily have been able to afford that expense.

The failure of the airplane for sport really has been due, in my opinion, to the fact that it was not sufficiently safe for the purposes for which the sportsman wished to use it. For many years the structure and control of the airplane have been such as to make it thoroughly safe while in flight. So long as one did not venture away from the flying field there was no danger. However, the sportsman is not content to fly round and round over his flying field. He wants to get about and see the country, and one who has never been up in a flying machine or balloon has little idea how beautiful this earth really is. He wants to travel from city to city. Flying over a single field, although incomparably more exhilarating and pleasant, is somewhat like driving an automobile on a race track only, in time it becomes more or less monotonous.

In order to create a real sport it will be necessary to provide means for flying cross-country without risk. There are several ways in which this can be accomplished:

1. The perfection of the flying machine and motor to that degree where forced landings will never be necessary.
2. The establishment of distinctly marked and carefully prepared landing places at such frequent intervals that one could always be reached in case of the sudden stoppage of the motor.
3. The development of airplanes of such design as to permit of landing in any ordinary field encountered in cross-country flying.

The first of these methods can hardly be utilized at the present time. Perfection in design and construction can only be arrived at through long experience and use, and experience and use can only be secured through perfection in design and construction.

The second method, while in many respects the more desirable of the three, is not easy of accomplishment on account of the expense involved. When flying at a height of one mile one can glide a distance of six to eight miles in any direction after the motor has stopped, to reach a landing place. Therefore, to make flying perfectly safe, good landing places must be provided every ten to twelve miles. For the high speed machines, such as are generally used today, these fields would have to be very smooth and measure at least a half mile on each side. The preparing of the surface of reasonably flat ground is an expensive undertaking, as has been shown in the preparation of the several training fields established by the Government. The improvement costs more than the land itself. There also would be a continuous expense for upkeep.

But when these landing places are once provided then flying will become common, not only for sport but for commercial purposes as well. Several times the flight from Dayton, Ohio, to Washington, D. C., has been made in airplanes in three hours. The best time from Dayton to Washington by rail is sixteen hours. And a few days ago a flight was made from Dayton to New York in four hours and ten minutes—less than one-fourth the best time by rail. Such flights would be exceedingly common if it were not for the danger involved in flying over ground where, if the motor should stop suddenly, no safe landing place would be within reach. Fields sufficiently large and smooth for our present high speed machines are exceedingly rare. But with the excellent motors and planes which have been developed as a result of the war forced landings would probably not occur once in a hundred such trips, yet one chance in a hundred is entirely too big a risk to take, if one expects to continue flying for long.

More and more landing places will, no doubt, be provided as the use of the airplane increases, but its use is heavily handicapped until these landing places are provided. In fact, unless undertaken by the Government, they cannot be realized for many years. For this reason the third plan seems the more feasible for the immediate future.

To land safely in ordinary fields a machine must either be able to fly at very low speeds or it must have some provision of coming to a stop quickly after it once touches the ground. The space required to stop after touching the ground is approximately in proportion to the square of the landing speed. An airplane which can fly 40 miles an hour and with a speed as low as 10 miles an hour will run approximately only one-fourth as far on the ground as if it were obliged to land at a speed of 80 miles an hour. For landing at 40 miles an hour a field eight or nine hundred feet square is sufficient; for landing at 80 miles an hour a field three to four thousand feet on a side would be necessary. The area of a field for the higher speed would be sixteen times that of the field for the lower speed. A fifteen acre field would be sufficient for the slow speed machine, while a 240 acre field would be needed for the higher. Clear fields one half mile or more square are exceedingly rare.

Not only does the high-speed machine require a large field, but it also requires a very smooth surface for landing. The shock of landing increases with the square of the speed. A bump on the ground will produce a strain four times as great when landing at 80 miles an hour as it does when the landing is made at 40 miles an hour. This advantage in favor of the slow machine is even greater than that due to the difference in the size of the fields required.

There are several ways in which the space required for landing may be reduced. One would be by using machines of large wing area and very low flying speeds. Another would be by providing some kind of brake to check the speed of the machine after it touches the ground. This has been attempted a number of times but usually with rather disastrous results. When a brake is applied to the wheels, a little more pressure on one wheel than on the other causes the machine to swerve from its course, often breaking the wings or the landing gear. Checking the speed by means of a reversible propeller has been suggested, but this method has several serious drawbacks. In the first place no reversible propeller of practical construction has as yet been produced, and in the second place such a propeller would be of no use in forced landing after the motor had stopped. A third and more difficult method would be by means of a machine which could rise and descend vertically. Experienced engineers look upon this method with the least favor on account of its many difficulties.

The airplane has already been made abundantly safe for flight. The problem before the engineer today is that of providing for safe landing.

The Martin Twin-Engined Bomber

By Donald W. Douglas

Chief Aeronautical Engineer, The Glenn L. Martin Co.

The Martin twin-engined bomber constitutes one of the most important developments in bombing airplanes of original American design. In its official tests, at Wilbur Wright Field, the all round performance of this machine, considering the load carried, has easily excelled any other record from a similar bomber, either here or abroad. The machine shows excellent workmanship and such thoroughness of engineering that the organization is to be complimented upon the talent of their personnel. Mr Martin is proud of the ability of his assistants, Mr Lawrence D Bell, factory manager, Mr Eric Springer, pilot, and Mr Donald W Douglas, aeronautical engineer, and he prophesies important futures in their respective specialties. Lawrence D Bell has been with Mr Martin for seven years, and is noted for his production management. Eric Springer learned to fly at the Martin School five years ago. He is an unusually capable tester and flyer, having made an enviable record in five years of piloting for the Martin Company without an accident. Donald W Douglas came from the Boston Tech, joining the Martin plant in Los Angeles four years ago, and in that short length of time has grown to be recognized as one of the foremost aeronautical engineers.—*Editor*

FIG 1. FRONT VIEW OF THE MARTIN TWIN-ENGINED BOMBER

The general characteristics which make this machine stand out from others of this type are its good flying qualities and high efficiency, which serve to assure us that the utility and practicability of the large machine for all uses, both commercial and military, have been definitely realized.

As to its maneuverability, it has been found a most comfortable airplane to pilot. With full load, and either with one or both engines running, it answers all controls readily and without undue effort on the part of the pilot. With only one engine on, it is possible to climb, to turn against the dead engine and to land comfortably in a small field. The machine has been looped repeatedly and with ease many times. It exhibits a remarkably quick recovery from a tail spin, and is, in fact, practically impossible to put into a spin, which characteristic is of great advantage in a machine of this type and high lateral inertia. With all controls released, it will pursue a steady and stable course for an indefinite period. In fact, the pilot has on different occasions left his seat and controls and walked about in the body. In spite of this stability, it exhibits no stiffness or dangerous tendencies in puffs.

In regard to its landing and handling on the ground, it is from all angles very satisfactory. The take-off is very quick with full load, both with and against the wind. It lands slow and pulls up in a remarkably short space. In taxi-ing, the two engines, of course, make it very mobile. It seems conclusive, from experience with this machine, that the large machine does not necessarily require larger fields than the small types.

The all-around efficiency of the Martin bomber has been proven in its official performance trials. An official high speed at the ground of 118.5 m p h was made on the first trials, with full bombing load on board. This speed has been bettered since, due to the better propeller efficiency arrived at by expensive experiments. With full bomb load, the climbing time to 10,000 ft was 15 min., and a service ceiling of between 16,000 and 17,000 ft was attained.

General Description

As a military machine, the Martin Twin is built to fulfill the requirements of the four following classes (1) night bomber, (2) day bomber, (3) long-distance photography, (4) gun machine.

(1) As a night bomber it is armed with three flexible Lewis machine guns, one mounted on the front turret, one on the rear turret, and the third inside the body, and firing to the rear, below and to the sides, under the concave lower surface of the body. It carries 1500 lb. of bombs and 1000 rounds of ammunition. A radio telephone set and the necessary instruments are carried on all four types. The fuel capacity in all four types is sufficient for one-half hour full power at the ground and six hours' full power at 15,000 ft. This gives the machine gasoline for the climb to 15,000 ft, and enough more for about six hundred miles.

(2) As a day bomber two more Lewis guns are carried, one more on each turret. The bomb capacity is cut to 1000 lb to give the higher ceiling necessary for day work.

(3) When equipped as a photography machine, the same number of guns as in the case of the day bomber are carried, but in place of the bombs two cameras are mounted in the rear gunner's cock-pit. One camera is a short focal length semi-automatic, and the other is a long focal length hand-operated type.

FIG 2 THREE-QUARTER FRONT VIEW

(4) The gun machine is equipped for the purpose of breaking up enemy formations. In addition to the five machine guns and their ammunition as carried on the photographic machine, a semi flexible 37 mm cannon is mounted in the front gun cockpit, firing forward, and with a fairly wide range in

elevation and azimuth. This can of ... either shell or shot, and is a formidable weapon.

The Martin Twin is easily adaptable to the commercial uses that are now practical. They are: (1) mail and express carrying, (2) transportation of passengers, (3) aerial map and survey work.

(1) As a mail or express machine, a ton may be carried with comfort, not only because of the ability of the machine to efficiently handle this load, but because generous bulk stowage room is available.

(2) Twelve passengers, in addition to the pilot and mechanic, can be carried for non-stop runs up to six hundred miles.

(3) The photographic machine, as developed for war purposes, is at once adaptable to the aerial mapping of what will

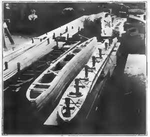


FIG. 3 CONSTRUCTION OF RIBS

become the main flying routes throughout the country. The accuracy that is being obtained in aerial photography should be of vast value in survey and topographical map work. The Martin airplane, with its great cruising radius and complete camera installation, presents itself as the logical machine in this field.

General Dimensions and Data

1.	Power Plant	
	Two 12-cyl. Liberty engines.	
2.	Wing and Control Surface Areas.	
	Main planes (total)	1070 sq. ft.
	Upper planes (including ailerons)	550 "
	Lower planes (including ailerons)	520 "
	Ailerons (each)	32.5 "
	No. of ailerons	4
	Vertical fins (each)	8.8
	No. of fins	2
	Stabilizer	62.25
	Elevator	43.20 "
	Rudders (each)	16.60
	No. of rudders	2
3.	Overall Dimensions	
	Span, upper and lower	71 ft. 5 in.
	Chord, upper and lower	7 " 10 "
	Gap	8 " 6 "
	Length overall	46 "
	Height overall	14 " 7 "
	Incidence of wings with propeller axle	2
	Dihedral	None
	Sweep back	None
	Decalage (wings)	None
	Stabilizer, setting with wing chord	+1
	adjustable between	[illegible]
	normal setting	[illegible]

Wing Structure

As shown in Fig. 1, the wing truss is conventional outside of each of the engines. From one engine through the body to the other engine, the truss system is a very rigid but light one of stream-lined steel tube tension and compression members.

These members are arranged primarily with three objects in view, that is, (1) Ease of removal of the engines. (2) Rigidity through the landing and power system. (3) Simplicity, and hence low weight and resistance.

The wing spars are of the conventional spruce eye-beam type. Interplane wood struts are two-part and hollow, and they are pin connected to the wing fittings. The wing ribs

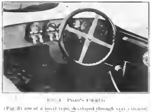


FIG. 4 PILOT'S COCKPIT

(Fig. 3) are of a novel type, developed through very extensive experiments on all types. They weigh each, eleven ounces and have a minimum factor of safety of eight. Scrap spruce is employed in their manufacture and by the use of a clever jig, speed and accuracy in their assembly make it a fine production job.

The wing fittings completely surround the beams in every case, and are designed from every minute consideration to give a factor of safety in excess of six. Double flying cables and single landing and incidence cables are used throughout. No

FIG. 5 ATTACHMENT OF UNDERCARRIAGE STRUTS

turnbuckles are employed. A right and a left-hand threaded eye bolt made into the cable by the conventional wrap method, engage similarly threaded clevises, pinned to the fitting. Stream-line wires are interchangeable with the cables in this system.

Swaged tie rods are used throughout for the internal wing bracing. Pin joint connections to the lower wings to the body tie through tubes, and are also used at all panel connections.

A minimum factor of safety of six is secured throughout the wing truss for the heaviest loaded conditions.

Body

The body in many respects is the most interesting part of the airplane. At the nose is the cockpit for the front gunner, mounting at its edge the Scarff gun mount. The front gunner has access to a passageway through which he can go aft to handle the rear lower gun, or sit beside the pilot on a folding seat. The pilot is placed on the right hand side of the body and well up so that his range of vision is the best possible.

He is provided with a wheel type control (Fig. 4) of a novel design, and has a splendid view of the instrument board. At his right and under his seat is the hand wheel which operates

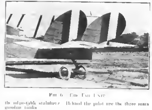


FIG. 6 THE TAIL UNIT

the adjustable stabilizer. Behind the pilot are the three main gasoline tanks.

The passageway and firing platform for the rear lower gun terminates at the rear wing beam station. Here, in a special mount, is the lower gun which commands a large field of fire horizontally to the rear, below, and to both sides. This gun is operated from a prone position by either the front gunner, rear gunner, or a third man, if four are carried.

The tunneling of the bottom of the body to permit the mounting of the lower gun has introduced difficulties in trussing which have satisfactorily been solved in a simple and light manner. The lower transverse strut and cross of transverse bracing wires usually found at each transverse section in the truss type body are replaced by two steel tubing struts.

The ends of these struts are threaded right and left handed, and engage similarly threaded forked ends which pin to the body fittings. By this means the transverse sections are squared up.

In all other features the body is a combination of two standard types, the wire and strut truss, and the veneer plated wood truss. Three-ply birch or mahogany veneer is used on the body sides, at the nose and tail, and in the bulkheads employed in the body. Swaged tie rods and threaded clevises are employed throughout for truss tension members. The longerons aft of the rear wing beam station are hollowed out between fitting attachment points, the degree of routing increasing with progress to the rear. A cheap, simple and effective steel plate longeron fitting is employed at the rear body panel points, while heat-treated chrome vanadium fittings are found at the main wing truss attachment points.

The tail skid is braced entirely by the internal body structure at this point. It is universally pivoted and is sprung by sturdy elastic chords inside the body to receive the landing shock.

Engine Units

As shown in Figs. 2 and 7, the Liberty engine is firmly mounted in a light girder box of veneer, resting on brackets on the four main wing struts. It is so secured that engine, radiator, airscrew and nacelle may be removed intact from the wing structure. A nose radiator of tubular cell construction, weighing complete 88 lb., and made by the Harrison Radiator Company, is mounted in a unique and very satisfactory manner. Two flanged steel rings are held together by machine screws, and when in place wedge a strip of rubber firmly between them and the faces of the circular hole cut in the radiator for the airscrew shaft. The rear ring carries plates, which in turn bolt to plates secured at the end of the engine bearers. The whole weight of the radiator then is carried from its central hole. No part of the radiator touches any part of the mounting, but has a cushion of rubber separating it from the mounting and absorbing the shock from the engine. Each radiator is equipped with shutters, operated at the will of the pilot, for the purpose of regulating the water temperature. An expansion tank is let in to the leading portion of the upper wing above each radiator, and is connected to it. As will be seen from Fig. 2, the top of the engine is exposed. This aids in cooling, of course, makes the engine more accessible for working over, and permits the reduction of cowling weight to the minimum consistent with low-head resistance.

The airscrew used is the Douglas type, and is 9 ft. 8 in. diameter and 8 ft. 4 in. face pitch. It is the best overall blade giving a satisfactory high speed and climb at reasonable revolutions.

The three controls from each engine, carburetor, ignition and altitude are positive controls, operated easily and conveniently by the pilot, either in pairs or singly.

An ample supply of oil is carried in a tank situated in each motor nacelle.

Undercarriage

The undercarriage is composed of four 800 by 150 mm. wheels. Four sets of triangulated struts carry the load from the two axles to the four main structural points of the machine. The axles are hung on the usual rubber cord suspension, but have a large amount of freedom not only vertically, but in the other two directions. All the lateral forces are taken up at the center trussing under the body. The two outside sets of struts are free to swing laterally, and hence only absorb the vertical component of the landing shock. Simplicity with extreme low weight and head resistance has in this manner been secured, but at no expense to the proper functioning and wear and tear resistance of the gear. The flexibility of this arrangement absorbs all kinds of shocks in a very satisfactory manner.

Controls and Control Surfaces

A single wheel and foot bar control is provided in the pilot's cockpit. The interesting point about the wheel control is that the usual weaknesses of this type have been eliminated. The

FIG. 7 CLOSE-UP VIEW OF CENTER PORTION

aileron cables pass over no drums, nor are they hidden within tubes where wear can be detected. The dangers of the chain and sprocket aileron control, with its ever present tendency to jam, are not encountered in this type (Fig. 4).

The 18 in. wheel is keyed to a steel shaft which carries on it, within the upper gear case, an alloy steel bevel gear. This meshes with another gear keyed to a vertical torque tube, running to ball-bearings mounted inside the control column. At the lower end, the torque shaft carries a pinion which engages with a steel rack. The rack is guided inside the lower gear case, and has attached to it the dual aileron control cables. The whole unit is very strong, rigid and reasonably light. Proper power on the lateral controls is readily obtained, which in the case of either of the other type would involve difficulties.

Four equal and unbalanced ailerons are carried. These sup-

ply the necessarily high degree of lateral controllability required of a machine of this type.

The tail surfaces are of steel and wood construction (Fig. 6). It is noteworthy that the stabilizer is adjustable from the pilot's seat The entire tail surface structure is hinged at the rear stabilizer spar The front truss system terminates in a vertical tube, mounted in bearings inside the body and threaded to engage a nut Cables wound on a drum operated by the hand wheel at the pilot's side turn the nut and thus raise or lower the front of the stabilizer, and with it the tail surface trussing A range in angle of the stabilizer of plus or minus three degrees from neutral gives the pilot a powerful means of balancing the airplane in any flying attitude or for any load distribution

The elevator is one piece, and, with its generous area and ease of operation, forms a positive control to be relied on in any emergency.

Two balanced rudders, working in synchronism, permit the pilot to control his direction under any conditions with ease In fact, when flying with one engine dead, the amount of rudder movement necessary to correct the off setting force of the other engine is surprisingly small It leaves an ample margin of control for maneuvering under these conditions.

Gasoline System

The gasoline system has been developed to eliminate the many troubles usually encountered from this vital part of the airplane Three sturdy tanks, mounted securely inside the body, contain the main supply of gasoline Two gravity tanks, mounted in the upper wing, one over each engine, each hold gasoline enough for one half hour's flight All tanks are made from the best tinned steel obtainable They are braced securely by many internal bulkheads. All seams are double lap, rolled and sweated, and all rivets used are large headed tinned copper rivets None of the tanks are subjected to any pressure when the system is in operation

The three main gasoline tanks drain into a combination distributing valve and sump operated from the pilot's compartment Any tank can be cut in or out of the line at will

Pipes from the sump lead the gas to the two air-driven gear pumps located below the body (Fig 5). Valves, controlled by the pilot from his seat, are provided in the pump lines. By means of these valves either pump may be by-passed on itself or allowed to feed gasoline to the carbureters. One pump alone is more than sufficient to feed both motors full on Two are provided as a safety means.

Leads from the pumps run out to the carbureters of both engines. A lead running from each of these main supply lines to the gravity tanks supplies them with gasoline and serves to carry off the excess gasoline pumped by the main pump An overflow pipe is led from each gravity tank to the main tanks

Fig 9 Three-Quarter Rear View

A hand-operated plunger pump of sufficient capacity is located conveniently to the pilot, and may be used to fill the gravity tanks or to supply the engines should both air-driven pumps fail

A gage in the bottom of one of the gravity tanks, visible from the pilot's seat, gives warning as to the operation of the pumps With one pump running and with both engines wide open, the gravity tanks will fill very rapidly

Gages are carried on each of the three main gasoline tanks, visible to the pilot When used for military purposes, all of the gasoline tanks are proofed against leaks from machine gun fire

Peace Time Uses

The Martin Twin is particularly well adaptable to the requirements of civil aeronautics be it for passenger, mail and express service, coast and border patrol, forest patrol, etc This adaptation does not involve any important structural changes, for the same machine, less the military equipment, is immediately serviceable for the carrying of one ton of mail, or of twelve passengers, at a speed of from 100 to 115 m p h Requirements of safety, so important in air transport, are specially well fulfilled by this machine because it can fly and climb on one engine only Efficient production tools on all of the important members and parts of the airplane will serve for both military and commercial machines, and in this manner a uniform production schedule of two machines per day will be reached and maintained during the year

Production Problems in the Martin Bomber

By Lawrence D. Bell

Factory Manager, The Glenn L. Martin Co

Whether to meet war-time demands, of peace time commercial competition, efficient and economic production is of great importance to the airplane industry. With this thought constantly in mind, both the engineering and production organizations of the Glenn L. Martin Company have carefully considered every detail pertaining to the production of the Martin bomber.

Not only have the detail parts throughout the machine been so designed as to accommodate the most modern production methods, but all minor and major units have been so worked out as to permit efficient and speedy progressive assembly This, together with the intense efforts of the production organization in studying and analyzing all production and assembly operations, is responsible for the efficient and economic production of this type machine

Practically all metal parts are of such design as to make them easily adaptable to standard machine tool equipment The tubing parts, in particular, offer remarkable possibilities for their production, as practically all hand work has been eliminated In the majority of these parts screw machine

products are used for the end fittings, which method makes unnecessary the usual hand flattening of the ends. Another important feature is the fact that the majority of the steel plate fittings, such as wing beam fittings, longeron fittings, etc, permits their manufacture entirely of blanking and forming dies. In fact, all fittings throughout the machine, such as steel tail surfaces, motor controls, flight controls, etc, are so designed as to reduce the hand work in proportion to the machine tool work to the minimum

For the production and assembly of the various parts, the tool design department, which has specified all operation methods, has designed numerous dies, jigs, machine tool attachments, and particularly assembly jigs, that have greatly reduced the cost of manufacture over other machines of similar type and size An example of the work of the tool design department is the wing rib assembly jig (Fig 3), which has proven to be an excellent method for the manufacture of ribs for many reasons One of the principal advantages of the use of such a tool is that it enables ribs to be made complete as a separate unit, permitting an extraordinarily fast wing assembly job The jig is so constructed as to not only permit the production of the full rib, but the nose and intermediate ribs are produced equally as well The various pieces of the ribs are first carefully cut to size and placed in the jig After the glue is applied, all parts are pressed together by a complete system of wedges which force the rib into its exact shape before nails are driven This produces a snug fit against the steel blocks, which represent the wing beams, with the result that when the rib is removed from the jig it can be slipped upon the wing beams, which have also been worked to close limits. It is readily seen that by this method it is a simple operation to assemble the wings, namely front and rear beam is placed upon the assembly table, ribs slipped on from each end to the proper spacing glued and nailed Both the front and rear ends of the ribs having been left unnailed permit the leading and trailing edge to be slipped in place, glued and nailed, which completes the assembly of the wing in much less time than the customary method of assemblying the beams, front, intermediate and rear webs, cap strips, leading and trailing edges, etc Another marked advantage of the rib in the Martin bomber is that it is entirely made of small pieces of spruce, permitting the use of practically all the scrap lumber from other parts of the machine

Mr Martin and His Assistants in Front of the Machine

The difficulty that is often encountered in the production of airplanes in securing lumber of sufficient size to make the interplane struts, longerons, etc, has been greatly reduced by making such parts of two laminations, each being routed on the inside so as to produce a hollow member

Another advantage offered by the Martin bomber is the ease with which it can be assembled This point has been so carefully worked out that the final assembly of the machine requires but a very short time, and no more equipment than the assembly of the ordinary single-engined plane While the wing panels are very large, they can be assembled to the machine one at a time by the usual number of men The center section, which extends over both engines, is assembled first and can be lined up as a unit The next operation is the assembly of each of the lower inner panels, which permits the installation of the engine support tubes, making the machine, thus far, self-contained The outer upper and lower panels are then assembled. The steel tubular struts fit with such exactness as to make all panels self-aligned when assembled Owing to the fact that the engines are mounted first in the nacelles with radiator, cowling and stream-line attached, the entire engine unit can be attached to a beam passing through the wings and lifted in place, making it necessary only to connect the engine controls and gas leads after the engine is installed The final assembly of the machine is so easily accomplished that it does not present any problem when assembled on the field

Much has been done to reduce the manufacturing cost of the Martin bomber by the efficient routing and planning of the work by the planning department This department upon receipt of blue prints and specifications from the engineering department carefully plans and times all operations so as to control the production of all departments on a very exact schedule Through this system it is possible to obtain production with minimum cost The efficient planning done by this department and their methods of record control during the experimental development of the Martin bomber made it possible to place the type in production almost immediately at the completion of the first plane The results of the system speaks for itself, in view of the fact that the organization took possession of its factory on May 1 this year, and the first plane made its initial flight on the scheduled date, namely, Aug 17, 1918

The inspection of all production pertaining to the Martin bomber is of most severe nature This inspection naturally begins with the inspection of all raw materials A specified number of samples of each lot of material are carefully inspected and tested. In the case of metals, a chemical analysis is secured, as well as physical tests made Furthermore, operation inspection is carried out through the entire production of every department, which makes it practically impossible for any inferior material or workmanship to appear in any part of the completed machine Also in cases where machines are to be delivered without being flown at the factory field, both engines are thoroughly tested to determine positively that all motor instruments, engine controls, gasoline and oil systems, etc, are functioning properly

Lord Weir on Air Transport

In the course of a speech he made on Nov 15 at the Enemy Aircraft Exhibition at Islington, Lord Weir Secretary of State for the Royal Air Force, emphasized the fact that the aircraft industry will need the assistance of the government in solving the problems and difficulties to be overcome before aviation can enter into its great commercial future He said among others

"I am not a pessimist in regard to commercial aviation I think the possibilities are great, the probabilities are not so great I refer to the immediate future A word of caution is necessary against those who predict an immediate, far-reaching and successful development of commercial aerial enterprise The actual practical limitations are still great, and just as at the beginning of the war we had to look forward to a period of pioneer work for military aviation, so we must look forward to pioneer work in commercial aviation In that work, which will be extensive, the State must play a large part and must continue to play a part It has supported the industrial development of aviation throughout the war, and I consider that it must assist that development and training until commercial aviation is well on its feet I am to have the advantage in a few days of meeting representatives of British aircraft manufacturers I have hopes that by discussion and agreement with them methods may be devised by which the State may be enabled to lend its support to the industry in the difficult times which are coming "

Air Transport and the Aircraft Industry

The termination of hostilities and the dawn of peace find the aircraft industry at the topnotch of its war-won expansion. However, the sudden return to peace time conditions, with the likelihood of the Army and Navy Air Services being considerably reduced both in personnel and material, raises the imperative question as to what shall be done to insure the aircraft industry the position it has acquired during the war through its skill and enterprise. Wholesale cancellations of various war time orders for aircraft particularly emphasize the urgent necessity of taking proper counsel and action with respect to this situation so as to open up new lines of activity for the aircraft industry and thus fully conserve and further develop the capital invested.

With a view to help solving this all-important problem, AVIATION AND AERONAUTICAL ENGINEERING is issuing the present Air Transport Number in which will be found authorized expressions of opinion by men prominently identified with the various aspects of aeronautics and the aircraft trade, as to how the American aircraft industry may be best and most speedily assisted towards creating new markets for its products.

In this respect the prospects offered by commercial aeronautics seem particularly worthy of attention. The progressive attitude of the Post Office Department with respect to aerial mail carrying affords the first practical demonstration of the fact that, once the initial difficulties attendant upon their organization are overcome, air lines may be operated on schedule with a regularity and at a cost which augur well for the future of air transport. Nevertheless, the whole subject of air transport has so far been touched on the surface only, and countless problems, technical, commercial, industrial, legal, etc., are still awaiting solution.

Insofar as they have a direct bearing on the immediate future of air transport, the following problems appear of particular interest:

1. Adaptation of present types of aircraft to air transport and sport, conditional upon minor changes, mainly affecting equipment.
2. Operation by aircraft manufacturers of commercial air lines, either singly, or else on a cooperative basis.
3. Assistance by the Federal government, or the aircraft industry, of municipalities or individuals willing to create properly equipped landing stations, supply depots, etc.
4. Government subsidy or other assistance to commercial air lines until they become revenue-earning.
5. Education of the public to realize the safety of air transport, given reliable machines and pilots.
6. Market available for standardized, low-priced airplanes for sportsmen.
7. Operation of excursion lines by airships.
8. Standard organization of aerodromes, and mapping of air routes.
9. Federal air legislation.
10. Creation, by the government, of a central experimental establishment, to be operated for the benefit of the aircraft industry.

The above are but the principal of the problems which, having arisen with the advent of the era of commercial aeronautics, require prompt solution in the best interest of the aircraft industry. The authorized expressions of opinion with respect to these and other problems, which follow, will afford the reader an interesting indication as to the line of action commercial aeronautics is likely to require for its organization on a sound basis.

Senator Charles S. Thomas

Chairman, Senate Committee on Coast Defenses

I am satisfied that the importance and development of the aircraft industry make it competent to take care of itself.

Of course, the manufacture of planes for military and naval service will soon cease, but the economic world has long ago perceived the value of aircraft as a superior medium of transportation whose possibilities and development are obvious.

The industry will, therefore, be transferred from a national to a private one, and within the next five years aerial transportation of passengers and merchandise will have been practically demonstrated and firmly established.

Otto Praeger

Second Assistant Postmaster General

Speaking from a viewpoint of the aerial mail, it is very desirable that a good market for airplanes be maintained in this country, also that the operations of an aerial service, whether for carrying the mail or other commercial purposes, be conducted without harassment through legislative restrictions by the various States of the Union. I believe these two points can be accomplished through federal legislation. Such legislation should provide a minimum of regulation, governing the factors of safety in aircraft production and of actual operations of the airplane in the air, to the end that aviation become neither a menace nor a nuisance to persons and property on the ground. Every manufacturer should be given the freest hand in developing types and that development should not be stifled by any military or civil body seeking to control experimentation, creation of types or production of machines.

If such restrictions, as I have reason to believe are contemplated by military men, are permitted, aviation will remain many years behind the airplane development of such countries as will permit the unrestricted development that commercial competition will naturally inspire.

Whatever legislation is enacted should be on the basis of federal control of transportation, communication, etc., in the air, leaving to the States and communities the necessary police regulation governing ground operations.

I can think of no greater danger facing the airplane industry than to adapt its operation during the next ten, twenty or thirty years of peace to the possible needs of the military in the event of war, and I can see no greater aid to insuring the development of the airplane industry than the development of airplanes for commercial uses and the unrestricted field to aeronautical engineers and builders to meet the needs of commerce.

E. P. Bertholf

Commandant, U. S. Coast Guard

The problem as stated to the aeronautic profession and productive enterprises appears to consist in the elimination to as great an extent as possible, of the disability to the industry caused by the recent abrupt change in the military situation. Disregarding the normal military demand which will continue after the conclusion of peace, a few fields suggest themselves in connection with the peace-time needs and wants of the public.

(1) The formation of aerial transport companies by private capital, independent of, or in conjunction with, the present carrier organizations on the land routes. There appear no technical difficulties here. The only question to be decided is, can it be made to pay; and this should be approached without delay by an enterprising group bent upon determining it practically, if that has not already been done, by computing costs of equipment, lease or purchase of landing fields, housing, personnel, routes, etc., and finally the rates that can be maintained. A preliminary survey of the situation should provide the answer. A soundly projected organization would not expect to specialize entirely in the carriage of the lighter and more valuable commodities, securities, mails and the like, nor to invoke novelty of means for procuring business. Business should be predicated on the ability to transport as safely and cheaply, allowing a differential for greater expedition of delivery, as existing agencies can or will transport.

(2) Combining passenger transportation with the above using the same plant. Here again we would be prepared to meet the competition of land routes but, it would seem, in less degree than in the transport of commodities. Land lines succeed in putting a time-rate differential on travel; air lines will doubtless be able to do the same.

(3) The adoption of the airplane and seaplane for convenience or pleasure by individuals. An organization for this purpose is in existence, and can be counted on to further it.

(4) Creation of an air service for the saving of life and property at sea and on the Great Lakes, along the coasts and rivers of the United States, and for search after derelicts at sea. A start was made on such a project by the U. S. Coast Guard in the year before we entered the war, and authorization

was obtained from Congress for the establishment and equipping of ten coastal stations. Unfortunately the funds therefor were not appropriated, and the stations could not be established. It is hoped to inaugurate this air service immediately upon the conclusion of peace, to enlarge it as occasion requires, and to employ it in conjunction with the vessel equipment of the service for the benefit and assistance of water-borne commerce.

Harry Bowers Mingle

President, Standard Aircraft Corp.

In diverting to peaceful pursuits the aircraft that have been manufactured from designs that were intended for a purely military function some consideration must be given to the limitation of the airplane of that type, adjusting the purpose for which the military airplane is to be used, to the means at hand rather than create at this time an entirely new type to perform a commercial duty, or at least until exact experience has been gained in the peace time uses.

The ultimate refinement of a purely utilitarian type of airplane will rapidly follow the experience gained in the actual operations of aerial transportation on a commercial basis.

Keeping in mind these limitations the training machine type, when released from the original duty of training aviators, and placed in the hands of experienced pilots, can be made to perform a very useful function in carrying the mail, light express packages and a reasonable weight of commercial commodities in the establishment of new air routes.

The pursuit type of machine will answer very well for the duty of patroling the air, as it is very fast and sufficiently mobile to perform that particular duty.

The post office type of machine which has been created purely for that service needs no further refinement other than to increase the weight-carrying capacity as the progress of the service warrants.

The DeHaviland type of machine could be used to a very excellent advantage in the work of mapping out air routes, establishing new landing fields and such general purposes as will be required in developing new routes between cities.

The flying boat could be utilized in its present function as a coast patrol, and with subsequent refinement for river and harbor duty as time goes on.

The Caproni and Handley Page machines will both be used to carry heavy weights and cover long distances with non-stop flights.

The extensive use of the larger machines will depend greatly on the activities that will be displayed in getting the number of available smaller machines in actual operation. As a general proposition, all of the present type of machines now owned by the Government or in the process of manufacture throughout the country can be utilized with a moderate amount of adjustment to civil purposes, and aid materially in developing and refining the Civil Aerial Transport enterprise to a high degree of usefulness.

To prevent a waste of effort in establishing the pioneer air routes, aircraft manufacturers could work to a most excellent advantage by combining their talent, manufacturing and engineering experience. They could also operate on a practical working basis, independent air lines between well-selected points throughout the United States. If they could agree between themselves not to nullify the efforts of each other by overlapping service, such efforts will be successful, bearing in mind at all times that the great purpose is to develop a Civil Aerial Transport service to a high degree of efficiency and within a minimum period of time.

The Government should exercise a parental interest in this newest civil establishment. The most effective means of getting the work under way on a well-established basis would be to subsidize the commercial air routes. This, however, only to the extent of personnel and such equipment as can be released from the military and naval departments, and only for so long a time as is needed to place a particular air route on a basis of commercial operation. As soon as this has been accomplished, to continue the same pioneer service on another selected route with the same object in view.

The revenue to be derived from an aerial route is all a matter of guessing, and the only way to get a clear idea of what will be the income is to get in actual operation a definite route. At the end of thirty days sufficient experience will have been acquired to indicate whether or not it would be within the limits of economy to continue the service.

The operation of aerial transport lines on a co-operative basis by the joint activities of aircraft manufacturers would be a most effective means of getting prompt results. If this can be effected through the efforts of the enterprising aircraft manufacturers it would be an undoubted commercial advantage to the entire country.

The Federal Government being the source of all supply which meets the demands of public interest and the public needs, it is, therefore, proper that the Government should organize air ports, supply depots, repairing stations and emergency landing facilities. The states, civic sub-divisions of states and individuals, together with the aircraft industry, should combine their efforts to assist and direct to the Government authorities a complete statement of their individual needs and a review of the local conditions.

Giving the Government the benefit of their experience in every possible way, even educating the public to the general use of aircraft, and to emphasize that as a safe means of transportation, these airplanes compare favorably with the automobile and railroad. This should be forcefully and earnestly undertaken at once, utilizing in that effort every possible sort of educational machinery.

An experimental station should be established by the Government for the purpose of co-ordinating aerodynamic research under a centralized control. We believe that this will do much to create new ideas that are fundamentally well grounded and which would prove to be of a high degree of usefulness. These ideas having heretofore been held in abeyance on account of lack of opportunity to give the fullest possible expression.

Charles H. Day

Vice-President and Chief Engineer, Standard Aircraft Corp.

Great as has been the progress of aviation during the last few years, to me it seems as nothing compared to the probable development immediately ahead.

The country will be covered with aerial mail and express lines. Already we have made a start in this direction. The six postal planes built by the Standard Aircraft Corp. have been carrying the mail between New York and Washington with a regularity and efficiency that prove that ultimately the airplane and not the railroad will be the great mail and express carrier of the country.

It will not be long before we develop a plane with landing speed slow enough to land and rise from very small spaces. Already we have planes that are so small they can be stowed away in a place little bigger than the average private garage. A machine of this kind, with a slow landing speed such as seems ultimately assured, will some day make Henry Ford sit up and take notice—for the sky flivver will be no more expensive to operate than its "earthly" brother.

Nor in the opposite direction does there seem to be any immediate limit. We already have planes that carry fifty passengers, huddled and crowded together. Soon we shall have an air-liner large enough to carry the fifty comfortably, surrounded by all the luxuries of the Pullman.

Here at the Standard Aircraft plant—where we have produced practically every type of plane used by the Army and Navy—we know what an airplane can do. And we know that wonderful as the past has been, it is as nothing compared to the aerial wonders of the future.

Glenn L. Martin

Vice-President, The Glenn L. Martin Co.

I consider a twin-engined, two-ton capacity, high speed airplane the most important vehicle of the air in commercial service because of its added reliability, due to the fact that one engine will fly and climb the machine with its two ton useful load, and is capable of handling bad weather to a much greater degree than the smaller types. The first immediate commercial application will be the transporting of aerial mail, forest patrol and coast patrol in connection with the life-saving organizations. It is expected that the Government will be the principal customer, however, for the next two or three years, but in that length of time I would prophesy that the industry will have reached such proportions that large factories can be supported at a profit from the commercial and sporting demands.

A most important and valuable application not yet encouraged in this country is the carrying of passengers. Important centers situated such as Philadelphia and New York should have a ten or twelve-passenger machine leaving a well-equipped

airdrome in both cities every half hour, and making the journey in less than half the time consumed by other means of travel. The cost of passage per passenger, while some higher than railroad rates, would not in any measure be prohibitive.

The development of aircraft for aerial mail, passenger carrying and first-class express should be carried on with the closest co-operation with the Division of Military Aeronautics because of the fact that military airplanes of the night and-day bombing and Corps d'Armee variety are parallel in performance and proportionate loading and speed, and machines of the above types should be identical with the passenger and mail machines, with the exception of the equipment inside the body, and perhaps a slight change in fuel capacity.

The important feature in the above is the fact that production tools would be in existence for quantity production for either application, and that the very important engineering features in both cases would be alike.

Regularity of commercial and mail-carrying flights is seriously hampered at the present by the absence of aerial terminals, landmarks and maps between such terminals, and navigation instruments to avoid becoming lost in rain, haze or clouds. The solution of such navigation must come through a development of the wireless compass and radio communication. Too much stress cannot be put on the importance of every city in the Union having in close proximity to its center an aerial landing terminal with every facility, including interurban and railway connections to the city in question, as well as motor boulevards leading to the important centers.

W. T. Thomas

President, Thomas-Morse Aircraft Corp

Present types of aircraft can be employed for air transport to a very large extent, especially such machines as the Handley Page and DeHaviland, the former for transport of express or light packages, the latter for extremely rapid transport of passengers and mail. These machines, of course, are necessarily not as efficient as machines designed expressly for such purposes.

Aircraft manufacturers should not organize and operate air lines directly, as their whole energy should be devoted to the design, demonstration and production of suitable machines and engines for commercial purposes. Separate companies should be formed for this purpose, in which the aircraft manufacturers could be financially interested and with whom they could co-operate in every way.

I do not believe that the Government should subsidize commercial air lines, but that they should encourage them in every way possible. They could not become revenue-earning from the start on a paying basis, but those financially backing this scheme should have sufficient confidence and be able to wait several years before making any money.

Nor do I believe in a joint action of aircraft manufacturers for operating commercial air lines, because, as above outlined, they should devote all their energy to design and production.

Municipalities or individuals should create the necessary air ports; this should not be left to the Federal Government. The aircraft manufacturers and aero institutions throughout the country should furnish all possible assistance to such municipalities or individuals.

The public should be educated by continuous hammering as to the safety of aerial transport. Figures and statistics should constantly be before them, proving that it is not as dangerous as commonly supposed. The aircraft trade should contribute to this propaganda by assisting the aircraft trade journals and others by taking advertising space.

I believe there is a market for the low priced aircraft for civilian flyers, but here again a great deal of press propaganda is needed to educate the public sufficiently to assure a sale of enough machines to allow their manufacture at a low price.

Finally, the Government should conduct a central experimental aircraft establishment for the development of war machines, but there should also be established an aerodynamic research laboratory operated for commercial purposes where designers or manufacturers could have work done with the utmost dispatch and with the least possible amount of red tape. It is believed that this should be privately operated or in connection with some of the aero institutions, similar, for instance, to the Automobile Testing Laboratory of the Automobile Club of America.

Col. Jesse G. Vincent, A. S. (P.)

I am very much afraid that the future of aeronautics is going to be jeopardized by a wholesale attempt to use the war machines, which are now available, for air transport work. These machines have been built strictly for fighting and bombing purposes, and, while some of the larger day-and-night bombers can be adapted to certain kinds of commercial use, they will never be ideal, or in other words, the best of these machines will fall far short of what could be accomplished by designing machines especially for commercial purposes. This closely resembles the car and truck situation. You can convert a touring car to carry a small amount of freight at high speed, but it is not an economical way to do heavy hauling.

Regarding the organization of air ports, supply stations, etc., I believe that the Government should start this work by establishing well equipped airdromes near the principal cities, and in addition to making them public landing places, use such airdromes as headquarters for the training of reserve officers of the Air Service. Such airdromes, under the command of proper officers, could recruit and train reserve officers, both as mechanics and pilots. This would arouse open enthusiasm, and there would be no trouble about keeping reserve pilots and mechanics upon "tip toe" to take care of any emergency.

Education of the public as to the safety of air travel should be carried on in various ways, both by the Government and the aircraft trade.

As to a central experimental establishment, I believe the Government should maintain a technical section and arrange to co-ordinate and direct future development. In other words, this section should operate as a Bureau of Information for the passing out of specifications and information to designers.

E. H. Wilson

President, Dural Rubber Corp

Thousands of uses for the present type of aircraft present themselves to men who have studied the subject, many of which are of such definite service to humanity they must not be overlooked. For instance, they will be used by overseers on large ranches and plantations, Government reservations and parks, and it is conceivable that the cowboy of the future will watch his herd from the air. In the sparsely settled West and Middle West, especially in mountainous country, there are towns, villages, mines, etc., wide apart if one travels by wagon or railroad that would be brought within a few minutes' ride of each other by airplane. They could be used for passenger ferry service over large streams.

Farm lands for returning soldiers can be quickly mapped to scale, and irrigation and drainage promptly considered by proper use of planes.

Undoubtedly airplanes will be the sport of rich people for some time, and perhaps the industry will follow through the same stages as the automobile industry did, before aircraft are accessible to the average man for pleasure and commercial pursuits. Whereas the war program called for speed first, we must now aim for "safety first," ridding planes of all war equipment and utilizing every available inch for carrying space. Landing speed must be reduced.

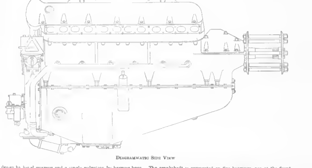
I do not believe that aircraft manufacturers can organize and operate air service lines. The problems of manufacture will absorb their attention and capital. Better results could be obtained from public utility companies organized for this purpose, either with or without governmental or municipal assistance. The Government has been taught a very forcible lesson from their previous neglect of the industry. We have suddenly become a peace industry almost before we were a full-fledged war industry. I believe that governmental financial aid would tend to stabilize the situation and insure the future.

The education of the public is an enormous task. People must be taught by performance, by magazine and newspaper advertising, that aircraft are a reasonably *safe* means of travel; that while they would be too expensive for ordinary usage for some time to come, the unique service that can be given by them will soon be an important factor in every-day life.

I believe the Government should conduct a central experimental aircraft establishment for co-ordinating aerodynamic research, experimentation and demonstration, both for its own use in Army, Navy, Post Office Department, Department of Interior, as well as for the industry itself.

The Curtiss Model K 12 Cylinder Airplane Engine

This engine, of the fixed cylinder type, consists of twelve cylinders arranged in two groups of six each, with an included angle of 60 deg. The bore is $4\frac{1}{2}$ in. and the stroke 6 in., the displacement of one cylinder being 95.4 cu. in. or 1.56 liters, and the total displacement 1144.8 cu. in. or 18.80 liters. In general, it may be stated that the engine is principally of aluminum construction, with inserted steel sleeves, four valves per cylinder, two exhaust, and two intake, overhead camshafts,



Diagrammatic Side View

driven by bevel gearing and a single reduction by herring bone gear to the propeller shaft.

Cylinder Sleeves and Cylinder Head

The cylinder sleeves consist of high carbon steel hydraulic forgings, rough machined all over, and heat treated. After treatment the bore is reamed close to size, and the outside finished, leaving the walls 5/64 in. thick with stiffening flanges spaced about 1 in. apart, a packing retaining flange at bottom, and an integral stud at the top. The upper end of the sleeve is slightly enlarged for a distance of $1\frac{1}{2}$ in. from the top and this portion is threaded to screw into the cylinder head.

The cylinder head proper is an aluminum casting, which, when assembled with six sleeves, forms a complete unit for one side of the engine. (This casting contains internal threads to hold the cylinder sleeves together with four ports for each cylinder, two spark plug bosses, necessary valve guide bosses, and braces for holding the camshaft bearings, together with pads and studs for the intake and exhaust manifolds.) The threads on the upper ends of the sleeves screw tightly into internal threads in the head casting, and to insure an intimate contact, the center of the head in the sleeve is drawn up singly with a nut, inside of the water jacket.

After the sleeves are in place, the upper and lower faces are re-machined to exact parallel, the valve holes are bored and seated, and the bores are carefully ground to size, thus insuring proper spacing and absolute squareness and alignment of the head and the cylinders. The spark plug bushings, of bronze, are inserted through the side, in the threaded portion of the sleeve. These have a taper thread on the outside, and 18 mm standard metric thread on the inside. When these bushings are properly screwed home, they insure that the sleeves will not by mischance have any tendency to back out and loosen.

The Crankshaft

The crankshaft is a 35-45 carbon chrome nickel steel drop forging—rough machined, heat treated, and finish machined. The crankshaft is supported on five bearings, one at the front end, one between each group of four cylinders, and two at the rear end, one on either side of the crankshaft reduction gear. The main bearings are all $2\frac{1}{2}$ in. in diameter, and are respectively $2\text{-}2\text{-}2\text{-}2\frac{3}{4}\text{-}1\frac{5}{8}$ in. long—starting with the front end of the engine.

The crank pins are $2\frac{1}{2}$ in. diameter, and $2\frac{1}{8}$ in. long, these as well as the main bearings are drilled out $1\frac{7}{8}$ in. In order to balance the long cheek between pins 1-2 and 5-6, steel counter weights, carried on aluminum spacers, are attached to these arms. This is done in order that the spool between pins 3 and 4 may be left normal size rather than greatly enlarged. An enlargement of this sort introduces additional stresses at the second and third main bearings, due to the centrifugal couple introduced at high speeds.

The front end of the crankshaft is equipped with an internal flange, to which a bevel gear driving the vertical shaft is attached with six bolts.

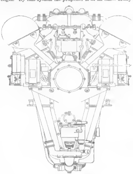
At the rear end of the crankshaft is a flange carrying the reduction pinion, a staggered herring bone gear, 5-7 pitch fellows tooth form, driven through nine 7/16 diameter alloy steel bolts.

Propeller Shaft

Mounted above the crankshaft, at a distance of 8 in., is the propeller shaft. This shaft has two journals—the front $1\frac{3}{4}$ in., the rear 4 in. long. The reduction gear rotates between these journals, and is fastened to a flange on the propeller shaft and driven by twelve 7/16 alloy steel bolts. On either side of the front bearing are fitted the thrust bearings, these being of the

ball and grooved plate type, and of ample size to take full propeller thrust in either direction

Integral with the propeller shaft is the front flange for the propeller, and the end of the shaft is splined to take the adjustable flange. These flanges are 10½ in in diameter and will accommodate propellers from 5¾ in. to 7¼ in thick The flanges are drilled for eight bolts, the bolts being driven into the propeller hub and centered at the flange by split conical wedges. By this system the propeller is at all times firmly held



Diagrammatic End View

in place, the disadvantages of the taper fit hub are done away with and greater lightness secured

Reduction Gears

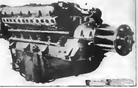
The reduction gears as before mentioned are 5-7 pitch Fellows stub tooth form, teeth staggered, one inch face per side Those are roughed out, then heat treated After this treatment the centres and faces are ground, and the gears are then re-cut, to insure accuracy and high mechanical efficiency in operation The standard reduction is from five revolutions of the engine to three of the propeller shaft

Crank Case

The crank case is an aluminium casting carrying the crank shaft, propeller shaft, and reduction gear, it extends up to form water jackets for the cylinders, the cylinder head and sleeves being bolted to a flange at the top of the crank case The upper part is bored out with six holes in each side, a recess in the bottom of each hole being fitted with a cork ring or gasket The cylinder sleeves are inserted into these holes, and the flanges at the bottom of the sleeves compress the cork ring into the recess and in so doing insure a water-tight joint between the water jacket and the crank-case proper A gasket is placed between the flange at the top of the crank case and the lower surface of the cylinder head, the head being securely bolted to this flange, which forms the complete water jacket system Numerous advantages may be cited for this construction, among them, that the water is directly in contact with the cylinder sleeve, another, that in this form of construction the effect of the combination of water jackets with their upper flange and the crank case itself produce a very rigid structure without the deflection found in engines where the cylinders are entirely separate from the crank case

The crankshaft is supported in five bearings which are in diaphragms and strongly ribbed to the case. The caps for the bearings are of rigid I-beam section with a generous amount of metal to support the bushings and insure that they remain in line Each cap is fastened to the case with four studs, fitted with special castellated nuts cottered. A large key prevents the cap from offsetting In case of the rear bearings the studs are continuous and extend through the crankcase, being properly fastened at each end, and form the principal studs of the propeller shaft cap This construction relieves the case of tensional stresses due to tooth pressure of the reduction gears and securely binds the rear end of the crankcase The cap itself is a nicely designed casting, with all ribs on the interior This cap is hand scraped to the crankcase, making an oil-tight joint to it, and is held on by several studs besides the through studs.

The bearings of the crank case are bushed with phosphor



Three-Quarter Front View

bronze bushings, lined with tin babbitt These bushings are held in place accurately with countersunk head brass screws and are all "full halfs," that is, there are no liners required on any of the bearings, but all maintain an accurate metal to metal contact between cap and crankcase As the journals of the crankshaft are all ground to the same size and the bushings are all reamed in a precision fixture with the same reamer, it stands to reason that the same clearance is accurately maintained throughout the numerous journals of the crankshaft

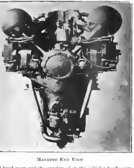
Lubricating System

The lubrication consists of a complete force feed system with auxiliary pumps to remove oil from above the oil pan deck

The pump unit is situated in the bottom of the lower crank case, and is driven through a horizontal shaft from the vertical accessory shaft The main casting, or body of the pump unit, contains the gears, one pair for the pressure feed and a triple group for the oil return system In addition, the gear shafts and spiral gears for driving the pumps are mounted hereon Surrounding this casting is a large fine mesh screen, properly reinforced against suction, for screening the sediment from the oil and preventing it from reaching the bearing surfaces The cover of the pump contains the necessary bypasses for the flow of the lubricant, together with a spring operated conical seat relief valve to regulate the pressure on the oil lines

The path of the oil is as follows: The oil is drawn through the screen and discharged from the pressure pump to the external pressure line This line carries it from the pump cover to a flange connection in the upper half of the crankcase This external pipe connects with the main feed line, which distributes oil to all of the main bearings of the crankshaft The main journals are hollow, with capped ends, the oil entering through a series of holes in the journal From here oil is led to each connecting rod bearing through a small steel tube built into the crankshaft. The lower wrist of the articulating connecting rod is fed from a bleeder hole in the connecting rod bushing In order to oil the propeller shaft, a portion of the oil is by-passed around the bushings of the two rear bearings on the crankshaft, hence through inserted copper tubes to the propeller shaft bearings, whilst a bleeder tube from the front propeller shaft bearing lubricates the teeth of the reduction gears

At the front end of the engine, oil is by-passed about the front bearing bushing and led through two drilled holes to the crank case deck level, where it passes through an external tube to each cylinder head It then passes through holes, which register in the front cam shaft bearing and leads into the hollow camshafts. Holes at each journal lubricate the bearing, whilst by-passes from one bearing across to the other insure against any one bearing running dry Oil is fed through a small hole in the exhaust cam shaft plug to lubricate the cam



Magneto End View

shaft bevel gears and the surplus oil in the cylinder head cover lubricates the valve stems, cam followers, etc, as there is a continual mist of oil around these parts.

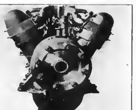
The extra oil in the cylinder head runs down the camshaft drive housing and lubricates the bevel gears, etc., on the vertical shaft, catches in the two oil cups on the vertical shaft bearing and oils the main vertical shaft bearing The surplus then runs down into the sump in the front end of the engine That from the cranks falls on the oil pan partition where it may run to the forward sump or to the rear The sumps are so shaped as to form a sediment cup, which may be emptied by means of a hole fitted with screw plug

From these sumps the oil goes through two tubes to the oil temperature regulator This regulator consists of a coil which is cored out with a water passage and two oil passages. The coil is well ribbed for heat dissipation, and water from the radiator on its way to the pump circulates through it The function of the regulator is the following as the oil in an engine does not circulate extra rapidly, the engine will get warm well before the oil On this account in starting, the engine will be warm and ready to function much sooner than the oil will have become warm enough to flow readily, the result being fouled spark plugs, etc By passing hot water through the ribbed coil, which is submerged in the oil, the oil is heated and reaches its proper running condition very rapidly Further, as the surplus oil must pass through the oil ducts on the return to the pump, any extra heat is transferred to the water After the engine has been under way some time, the regulator acts as a cooler, because the water will be cooler than the oil, thus the oil cannot reach a temperature which will be dangerous to the engine by breaking down its qualities as a lubricant The oil after passing through the two ducts in the regulator is passed through triple return pump, then to the oil chamber to be re-circulated As the two sumps are on separate lines throughout, there is no danger of the pumps stopping due to the engine running for some time in an angular position The oil pan is equipped with a gage which is calibrated in gallons, showing the amount of oil in the tank at all times. The filler is on the upper half of the case, by-passing through to the oil chamber, that the oil may be conveniently put in the engine and a main drain plug fitted that the oil pan may be emptied

The pressure regulator spring is adjustable in order that any desirable pressure may be carried, in accordance with the class of service in which the engine may be used.

Valves and Valve Gear

Each cylinder is equipped with four valves, two intake and two exhaust. These valves are interchangeable The clear opening is 1⅝ in. diameter while the seat is 1/16 in wide These valves seat directly in the steel cylinder head, insuring absolute tightness on the explosion stroke The valves are guided in cast iron bushings which are fitted into the cylinder head casting on a slight taper A flange forms a seat for the inner valve spring, while the extension above the flange is threaded to facilitate removal by means of a special tool furnished with each engine Each valve is seated by two concentric alloy steel coil springs which are held at the top in a steel spring seat This spring seat is bored taper and held in place by a split taper sleeve threaded on the valve stem, thus



Airscrew End View

allowing fine adjustment of spring pressures necessary in the correction action of high speed engines The taper sleeve is locked with a straight pin

The cam followers are yokes, each embracing the tops of a pair of valves, and provided with a ground stem sliding in a bushed guide between the valves. The end of the valve stem is held in an adjusting nut which, in turn, is locked with a clamp screw Proper clearance for the cams and followers is obtained at this point

The Cooling System

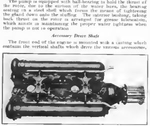
The cooling is by centrifugal pump, the pump being coupled to the lower extension of the vertical shaft This pump is of the double shrouded type with the intake on the lower side The water is drawn from the lower points of the radiators and passing through the oil temperature regulator enters the pump through the pump cover casting The volutes extend half way round the rotor on each side, and the discharges bend up to connect with two tapered manifolds which deliver water to the lowest point of the water jacket in each cylinder The water surrounds the cylinder sleeves and, passing through a series of drilled holes, enters the cylinder head There it circulates

around the ports and is taken off at a point between the valves on each cylinder From here the water goes through ducts cast in the intake manifold and enters the intake manifold Y-water jackets in order to heat the elbows and assist in breaking up the gasoline and keeping the mixture from becoming too cold on account of the cooling of the gases as the gasoline vaporizes. The water is then led off and returns to the radiator

The pump is equipped with ball-bearing to hold the thrust of the rotor, due to the suction of the water lines, the bearing seating in a steel shell which forms the means of tightening the gland down onto the stuffing The interior bushing, taking back thrust on the rotor is arranged for grease lubrication, which assists in maintaining the proper water tightness when the pump is not in operation

Accessory Drive Shafts

The front end of the engine is mounted with a casting which contains the vertical shafts which drive the various accessories,



View from the Top

namely, the water pump, the gasoline pump, the magnetos, and the tachometer

This casting of aluminum consists of a housing for the vertical shafts, magneto pads with brackets, water pump pad, gasoline pump pad, pads for fastening the camshaft drive shafts and tachometer drive housing and a hand pole for inspecting gears, etc

The upper vertical shaft which runs in bronze bushings at the lower end, and an annular ball bearing at the upper, has a bevel pinion at the bottom which meshes with the gear on the front end of the crankshaft This pinion is held in proper position by shims, whilst the crank gear is placed in position by cutting off the end of the crankshaft to gauge after carefully lining the shaft up in the crankcase

The vertical shaft is geared to run $1\frac{1}{2}$ times crankshaft speed

At the upper end of the shaft are located the pinions for driving the camshaft driving shafts and the magnetos Those pinions as well as the lower pinion are held to the shaft on fine pitch splines, giving fine adjustment, positive drive, and a saving of weight The lengthwise position is afforded by shims, and after all adjustments are made, the whole groups of pinions and the ball-bearing are locked in place with a lock nut

In engines equipped with a tachometer drive, this nut is furnished with a spiral gear on an extension which in turn meshes with a horizontal pinion mounted in annular bearings the end of which shaft is machined to connect with the end of the flexible tachometer shaft

Mounted on each side of the gear case are the magneto drive gears, those being mitre gears running at equal speed with the vertical shaft The magneto gears are mounted integrally on hollow shafts and rotate in bronze bushings The male portion of the magneto coupling is secured to the magneto gear by means of a fine pitch spline The whole unit is mounted in a steel housing and held in place by four studs through a square flange

Directly below the vertical drive shaft, and meshing with the crankshaft gear is the water pump drive pinion This also rotates at $1\frac{1}{2}$ times engine speed The shaft, which is integral with the gear, runs in bronze bushings, and has a worm cut between the two journals by which the gasoline pump is driven The oil pump drive gear is mounted on the lower end, together with suitable thrust washers and shims for properly meshing the gears. The lower end of the shaft terminates in a square portion this and the square end of the water pump shaft are joined by a short steel coupling, giving the necessary flexibility for such a drive In this case, opposite the crank shaft is a suitable flange on which may be mounted a geared reduction hand starter when necessary

Camshaft Drive and Camshafts

At the top of the gear housing, and at an angle of 45 degrees with the centre line are mounted the camshaft drive shafts. The gears, which mesh with the upper gear of the vertical drive shaft, are integral with the drive shafts and are mounted in ball bearings. The lower bearing is housed in an aluminum case, while the shaft projects through a tubular housing having a telescopic joint at the lower end to take up any movement due to expansion etc The upper bearing is securely mounted on the shaft, but free to float in the drive shaft housing, and is just below the camshaft drive pinion which is aligned by shims and securely held by a lock nut

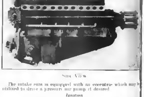
The camshafts are mounted on the top of the cylinder heads, one shaft over the exhaust valves and another over the intakes. These rotate in opposite directions and are driven in relation to one another by right and left hand helical gear sets These gears are indexed in the cams, and being of opposite thread maintain the proper timing and longitudinal position

The main cam drive gear is bolted to a flange on the forward end of the exhaust camshaft and is timed by a set of vernier holes. The thrust is taken on the back of the flange

The shafts are mounted in aluminum brackets one and bearings being located between each pair of cylinders

The cams are cut integrally with the shafts, as are the two helical gears, and the necessary flanges, etc The material is low carbon steel, carbonized and hardened and finished all over by grinding

The cams are such shape as to produce a constant acceleration and retardation in the valve opening and closing, and lift the valves .406 in.



Side View

The intake cam is equipped with an eccentric which may be utilized to drive a pressure air pump if desired

Ignition

The ignition is by high tension magneto, two-two spark six cylinder magnetos used These are driven through elastic block couplings through gearing from the vertical shaft

There are accommodations in each cylinder for two spark plugs, which are connected to the magnetos by wire assemblies enclosed in rectangular insulating wire tubes

Carburetion

The engine is equipped with two 52 mm duplex Ball and Ball Carburetors Each carburetor furnishes gas to three cylinders through a fan-shaped manifold. This is water jacketed to assist in vaporizing the gasoline

Pistons

The pistons are cast in aluminum alloy They are of the trunk type, with long ribs under the head to insure maximum strength and quickly dissipate the heat. The main rib is of

circular form concentric with the skirts. This gives even expansion, and also in joining the piston pin bosses, stiffens them against deflection The cross ribs stiffen the skirts and help carry the heat to them

There are three piston rings per piston, the two upper rings being ⅛ in. lace, while the lower ring is 3/32 in An oil collecting groove is directly below the lower ring, with oil holes drilled to the piston pin bosses

The piston pin floats in both the piston and connecting rod, and is held against lengthwise motion by two snap rings.

Connecting Rods

The connecting rods are articulating They are alloy steel drop forgings, heat treated and finished all over The master rod carries a bronze back babbitt lined bushing, secured by a cap held in place by four bolts A lug is formed on one side, in which the wrist pin is held by a clamp screw The link rod strides this lug, and carries phosphor bronze bushings. The upper ends of both the master and link rods contain bronze bushings for the piston pins

Crank Case, Lower Half

The lower half of the crank case is flanged and bolted to the upper crank case at the centre line of crankshaft It contains the oil pump, oil pump drive shaft, oil temperature regulator and oil reservoir The reservoir is closed by a sheet of aluminum, held on a flange, this partition forms the oil sumps at either end and prevents the oil from flooding the crank case when the engine is in positions out of the normal

Conclusion

In conclusion, there are certain outstanding features which justify the design of the K-12 engine, among them being the general layout, gear reduction, aluminum construction, etc

It is noticeable that the engine is very compact, and generally shaped that its adaptation in an airplane is remarkably easy

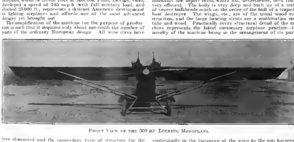
The gear reduction raises the centre of thrust to a point near the centre of gravity, and close to the centre of projected area This enables the design of the body or nacelle to be reduced in size, with consequently lower head resistance It also enables high piston speeds to be maintained, which with the engine's normal high mean effective pressure increases the power output without increasing the propeller speed above a normal figure As a slow speed propeller is from 5 to 7 per cent more efficient than a high speed propeller, the geared down engine will deliver a greater net power per pound of gasoline, consequently the overall efficiency is greater

The Loening Two-Seater Fighting Monoplane

The Loening two-seater fighting monoplane, 300 hp Simplex-Hispano, which in recent tests at McCook Field, Dayton, Ohio, developed a speed of 145 m p h with full military load, and climbed 25 000 ft, represents a distinct American development in fighting airplanes and affords one of the most advanced designs yet brought out

The simplification of the machine for the purpose of production is such that it requires only about one-tenth the number of parts of the ordinary European design All wire stays have

The Loening monoplane is 32 ft span by 7 ft chord, a remarkably low aspect ratio, which has, nevertheless, been found very efficient The body is very deep and built up of a series of veneer bulkheads much on the order of the hull of a torpedo-boat destroyer The wings, etc., are of the usual wood construction, and the large bracing struts are a combination steel tube and wood Practically every structural detail of the machine represents the latest customary airplane practice—the novelty of the machine being in the arrangement of its parts,



Front View of the 300 hp Loening Monoplane

been eliminated and the monoplane type of structure for the first time rendered as strong and rigid as any biplane without losing any of the well known advantages of the monoplane

Another important feature of this design is that stability and control in all maneuvers have been found to be so satisfactory that it may be said to be one of the first load carrying machines that can be maneuvered like the smallest single-seater

The performances of the machine as a two seater are superior to the European single seaters with the same type of engine The Loening monoplane carries practically double the load that is carried by the latest Sopwith and Spad machines in Europe, with an even greater climb and speed

The machine weighs 1300 lb dry and carries practically the equivalent of its entire weight in live load Previous machines have only been able to carry about 50 per cent of their weight in load. The reason for the increased efficiency was found by the Army authorities to be in the design of the airplane structure, which was so light and simple that it weighed practically one-half of what the two-winged machines usually weigh

particularly in the fastening of the wing to the top longerons of the body, a new feature which has not heretofore been used

Due to the manner in which the wing has been mounted on a level with the pilot's eyes, the visibility is such that the pilot and gunner have practically no blind spots. The machine carries the heaviest load per square foot of wing surface that has ever been successfully carried, and yet the landing speed is very low Indeed, the machine has a speed range of over 100 m p h

From the very beginning this machine, the design of which was proposed by Grover C Loening last spring—after he had studied all the latest types of airplanes in Europe—has been encouraged by the Air Service in every possible way, despite much skepticism on the part of European experts.

In its official trials the machine, with a military load of two men, four machine guns and 2000 rounds of ammunition made a speed of 145 m.p.h and climbed 10,000 ft in 8 min., maintaining its speed well up to high altitudes. The greatest height reached was 25,000 ft

The Outlook for 1919

By Archibald Black

Aeronautical Mechanical Engineer, U S N

While the stage of aviation upon which we are now entering will call for entirely new developments in design, the present military types—with the removal of guns and equipment—appear to find their places in one phase or another of the immediate market ahead.

In considering the adaptability of our existing machines to other uses it is important to keep in mind that, in the United States, our quantity production has been limited to a comparatively small number of types and it is only with such types we have to deal when discussing the adaptability of our present machines to other uses.

There are three points to be considered in discussing the immediate future of the aircraft industry. These are (1) the disposition of machines now overseas and the disposition of machines or parts completed and on hand in the United States, (2) the prospects of aircraft factories continuing to turn out, in lesser quantity, these types as adapted to other uses, (3) the market for new types in the immediate future.

1 *Disposition of Existing Machines*

Three Government departments, at least, will require aircraft. These are the Navy, War and Post Office Departments.

Navy Department.—As our Navy is to be maintained at a higher standard than before the war, it is certain that few if any of the Navy machines will be disposed of and indeed an appropriation of $900,000,000 has been asked by the Secretary of the Navy for maintenance and construction of aircraft, which would even show promise of new business for the manufacturers. The report has been published with some foundation on fact, that the Navy Department proposes to purchase six dirigibles of the Zeppelin type at $1,500,000 each.

Air Department.—The Army has at present a surplus of machines of both service types and training types in addition to a considerable surplus of engines. A large number of the Army planes will be taken over by the Post Office Department during the coming year and the writer has been informed on good authority that it is practically certain that, by the time the Post Office is supplied, the Army will have few if any more machines to dispose of. The surplus it may will most probably be disposed of within the year 1919 and it would appear advisable to dispose of as many as possible to foreign governments in order to protect our own manufacturers against a surplus of machines on the domestic market which would also result in great loss to the Government through the forcing down of prices.

Post Office Department.—The Post Office Department will require within several months, between 500 and 1,000 machines. This Department has already offered to take over several hundred of the Army's machines.

2. *Market for Present Types*

The market for present types, with slight alterations, is probably divided between sportsmen, mail carrying, and miscellaneous commercial uses.

In the case of the sporting field practically all existing types, except the largest, are already fairly well adapted to this use. The smaller and lower powered machines, like the Curtiss JN and Standard J, are particularly suited. The extent of this market is, of course, problematical and will depend greatly upon the large number of young men of independent means who are now in the air service. Flying boats and seaplanes may be expected to be very popular among these men. It is worthy of note here that it is possible to land in the heart of many of our larger cities with water types of machines, a feature which is certain to make for popularity of these types.

As the Post Office will, probably, obtain from the Army the majority of the machines required for immediate needs, it would not appear advisable for manufacturers to depend upon the Post Office Department for extensive business. At the same time it is well to note that existing types are only makeshifts for mail carrying.

Doubtless many commercial uses will develop for our existing types in the near future, but such uses are not sufficiently definite at present to warrant lengthy consideration. In the humble opinion of the writer the commercial development will require new types rather than an adaptation of present types.

3. *Market for New Types*

This brings us to what is, no doubt, the most interesting development ahead. Future sporting types of machines will very likely be confined to refinements in present design rather than very radical changes. On the other hand, the development of the commercial plane, the future of which looms large to the writer, will call for radical modifications. The chief field of commercial aircraft will probably be confined for some time to passenger and mail carrying, although numerous miscellaneous uses will probably develop within the next few years. One use of aircraft which may develop largely in the near future is that of transportation in snowbound sections of the world where transportation is practically tied up in winter. The writer expects a most extensive development of this service.

Passenger Carrying.—In order to transport passengers on a commercial basis it becomes almost essential to carry 30, 50 or even 100 passengers in order to keep down the per capita operating costs. Interesting developments may be expected along such lines. One of the first may be expected to be the furnishing of a commodious enclosed cabin in the body, built along the general arrangement of the railway coach. Radical developments in wing settings will come into vogue in the endeavor to keep down the span of wings. It will probably become necessary to adopt even wing arrangements which are known to be less efficient. In this respect the triplane and tandem "following plane" arrangement would appear to show most promise.

With the taking over by the Post Office Department of Handley Page and Martin bombing planes, we will soon have in the monthly reports of the Aerial Mail Service some data upon which to base a crude estimate of the cost of operating planes of this type.

Mail Carrying.—Present types used for carrying of mail can only be considered as makeshifts. Several important requirements suggest themselves at once. The foremost is probably the necessity of a sorting cabin so that mail may be sorted en route. This requirement rules out almost every existing type, as it necessitates a large body and a machine of fairly high speed—probably not less than 110 m.p.h. Of all machines on the American market at this moment, only one, the Martin Bomber is worth consideration. This machine is a type capable of carrying from 3000 to 4000 lb. and has made 114 115 m.p.h. The body is sufficiently large to permit the adaptation to accommodate mail sorting facilities—although somewhat cramped.

Next in importance is the provision of means for the dropping and picking up of mails without landing. The former is simple but the latter presents great, though by no means insurmountable, difficulties at this time. The perfection of such means, however, would make it unnecessary to carry mail several miles from the center of each city to the flying fields—thus cutting the transportation time still closer. In addition, such devices would make it practicable to collect mail from and deliver it to the smaller towns along the line.

Given experienced pilots and large machines capable of slowing down their speed, it seems well within the limits of probability that means somewhat similar to that in use on the railroads for picking up of mail bags may be devised and used successfully. With such facilities provided, the railroad train as a mail carrier would be doomed.

In a discussion of this project I was informed by one of the officials connected with the Aerial Mail Service that a drop of 100 ft. or more would not injure ordinary mail in the regulation bag, and it would appear possible to develop a special mail bag for this purpose.

Landing Fields.—The landing field problem appears to be nearing a solution along with the development of the Aerial Mail Service. The commencement of the Aerial Mail Service on as large a scale as is contemplated will require the establishing of landing fields throughout the entire country, and

if the Post Office Department adopts a liberal policy by making provisions for the use of all except restricted parts of these fields by privately owned machines, a very great impetus will be given to the commercial and sporting development. In a short time, no doubt, private fields would be established by enterprising municipalities en route between the large towns, and such landing points could be made to prove extremely good investments for many municipalities. It will probably take some time to fully appreciate the fact that towns now in the heart of the country will be brought within an hour of some great metropolis.

It would seem advisable that the manufacturers—fortunately already organized—cooperate both with the Post Office Department and with private individuals in the establishing of landing places. It certainly appears likely that such fields could be made good paying investments in a very short time. Landing fields could in a short time no doubt prove excellent centers for the location of high class restaurants, hotels and open air diversions.

Research. As to the continuance of scientific research it is well to note that we have now reached the point where an elaborate equipment—beyond reach of any but the larger manufacturers—is required. Such laboratories are already established in this country under the control of the War Department at McCook Field, Dayton, Ohio, the Forest Products Laboratory at Madison, Wis., the Bureau of Standards at Washington, D. C., and the Navy Department, Navy Yard, Washington, D. C. Only those who have been closely in touch with the development of the aeronautical equipment of these institutions have had the opportunity to fully realize the enormous investment of the Government in the scientific development of aircraft. With such already established it would give our manufacturers enormous advantage if the work of research is continued—even if on a lesser scale—and at least part of the data obtained made accessible to every American designer. Some of us have been unusually fortunate in being closely in touch with all of the developments, but many others have been on the outside, and it would be distinctly to the advantage of the country if the information was made available to all, following the pre-war policy of the British Government.

Peace Time Aviation

By Ottorino Pomilio

Of Pomilio Brothers Corp

To the superficial observer it might appear that the end of the war has thrown aviation into a grave crisis. Actually, there has been a crisis, and this will manifest itself still more in the next few months, but its cause lies essentially in the fact that the mighty aeronautical industry, created by the war, suddenly finds itself, due to canceled war contracts, without work before having had the time to prepare a peace program. It is now admitted and recognized, even by the most extreme pessimists, that aerial locomotion is getting ready for its definite entrance among the means of locomotion employed by men.

Unfortunately, a large number of people, and generally not through their own fault, but essentially due to the censorship which during the war only permitted the publication of incomplete or uninteresting news, have not yet formed an idea of what the airplane is today, of what it can give accomplish at present, and will be able to do in the more or less near future. Therefore nothing could be more timely, in the interest of aviation, than the questionnaire which the AVIATION AND AERONAUTICAL ENGINEERING has addressed to all those closely connected with aeronautics, a questionnaire which involves the most important problems of peace aviation.

The types of airplanes which form the legacy left by the war for peace aviation cannot at once be employed as peace types without first going through a number of more or less deep transformations which will reduce what may be called their military efficiency, now become useless, while increasing instead their commercial efficiency, which is what interests us.

The essence of transformation is not so much the substitution of the military loads proper (armament with its supports, ammunition, bombs, etc.), which is self-evident, as a more efficient use of the high engine powers to which the war has brought us. The present military machines lift a load varying from 14 lb. hp., for the night bombing machine, to a minimum of 7 lb. hp., for the single seater fighters. It would be a grave error to descend to these low limits for peace types of airplanes. The 14 lb./hp. load, if not representing a minimum, would seem very near to the minimum.

Since the airplane cannot affirm itself but in long distances and in long crossings, and since every stop, for the renewal of the fuel supply, lowers considerably its commercial speed and introduces an unknown factor in the equation of the distance covered, the great importance of being able to transport heavy fuel loads, that is, to increase the load lifted per hp., is evident. This becomes a condition *sine qua non* for long oversea flights.

Military aviation required essentially the possibility to rise to high altitudes, up to 20,000 ft. and over, either to escape from the enemy or to attack him if he were flying at those altitudes. The attainment of this result required an enormous waste of power, since, as is known, the present internal combustion engines suffer a decrease in power proportional to the decrease of the density of the air. So it was that we found engines of 300 or 400 hp. installed on machines which to fly near the ground, would have required only 100 or 200 hp.

Peace time aviation in its applications to transportation of either mail or passengers will therefore have first of all to renounce to high altitudes, which is of no great consequence in a country like the United States where there are few mountainous sections, and which is very possible for oversea flights. Certainly, if there is a country which because of its configuration, its position in the world, the very character and spirit of its inhabitants, is destined to give a great impetus to commercial air services, that country is the great North American Republic, and the fact that the first men who succeeded in lifting themselves into the air, were two Americans, Wilbur and Orville Wright, sounds almost like a prophecy.

And today with the creation and production on a large scale of the most powerful engine in the world, the Liberty, with the existence of numerous and magnificent airplane factories, and more specially with the development of hundreds of thousands of mechanics, motormen, assemblers, pilots, technical men, etc., the people of the United States find at their disposal a colossal wealth of energy and means which not only should not be squandered, but must be gathered and multiplied.

The great air mail organization should be financed by the government, since complete success can only be attained by an organization built up with powerful technical means. The undertaking, if well planned, so as to efficiently employ the individual energies of the great industrial leaders of America, could not be but an excellent investment for those financing it.

The financing by the government could be effected either through direct control of the air lines or through subsidies with the right to a part of surplus profits. Meanwhile, it may be deemed urgent to nominate a senatorial committee which, with the help of experts, both pilots and constructors, should make a comprehensive study of the problems of present day aeronautics, and state its immediate possibilities by gathering the elements necessary for opening a great contest with the object of stimulating constructors towards creating those types of commercial airplanes whose need is more intensely felt.

Naturally, to supplement this, it will be necessary to give a maximum impulse to the creation of landing fields so as to create not only great air lines for linking great centers, but a close network of lines, such as to insure the safety of flights in every direction.

As it is, it may be foreseen that as soon as the first great network of air lines comes into operation there will be a great demand and competition for the service and this, in contrast with what is the case for water navigation, will be a very easy task for the airplane, since it may be easily produced and dispatched in all directions.

We must repeat, however, that the great future of aviation depends on very long flights. To connect the United States with Europe, Central America, South America, Asia is the goal toward which we must direct our efforts.

Curtiss

"THE OPE BOOK"

Curtiss Achievements — The Great War

1—The design and construction of the fastest fighting airplane ever ... Official Government records credit this triplane, which was built for the U... Navy, known as model 18-T, with 160 miles per hour, carrying full milita... load, pilot and passenger This is 15 miles per hour faster than any ... ever claimed for an airplane, a truly epoch-making achievement, made poss... by the development of our new model K motor.

2—The design and construction for the Navy of the largest flying boats in th... world, colossal crafts capable of carrying five tons useful load It was ... of these boats that recently carried fifty passengers

3—The design and construction for the U. S. Navy of the fastest and most ef... cient Seaplane in service anywhere This craft, which is known as the Curti... model H-A, with Liberty motor, made an official speed of 126 miles per ho... with full military load, armament, ammunition, pilot and passenger

—The development and construction of a 12 cylinder, 400 H.P. motor of an entirely new and much lighter type, known as the Curtiss model K-12 These motors have undergone exhaustive tests and are already in production

—The development and construction of the Curtiss model K-6, a new and much lighter 6 cylinder motor. This engine develops 160 H.P. and possesses greatest endurance and reliability

6—The development and construction on a large scale of the Curtiss OXX motors, and the J-N-4 training planes, which were used almost exclusively by the United States and Canada and largely in England for the training of American and British aviators The training of over seven tenths of the original land and marine flying pilots most of whom entered the service and formed the nucleus of the United States Aerial Training Forces

The Curtiss Engineering Corporation is today the center of ae... ...t. Its activities, instead of being decreased, will be increased by the coming of peace. Glenn H. Curtiss and his engineers have been busy in ... s, research laboratories, wind tunnels and shops in perfecting designs and carrying forward the production of suitable commercial types Aircraft ... designed for sportsman's use, mail carrying and other peace-time purposes are already available, and are as superior in design, workmanship and ... Curtiss military planes have proved themselves to be.

CURTISS ENGINEERING CO...TION, GARDEN CITY, L. I.

Problems of Commercial Aeronautics

By Capt. G. Lepere, French Air Service

Aeronautical Engineer

The termination of hostilities provides an opportunity to use some of the numerous military planes actually built and ready to fly. It seems difficult to adapt these to passenger transportation, the actual machines not giving sufficient safety and comfort.

General Considerations

For the mail service, the de Havilland, however, can be used as a single-seater with slight modifications. Big bombing planes with two or three engines seem too heavy and slow to be adaptable to such a service. They could not be operated efficiently.

Improvements in aircraft construction during the war enable us to create immediately new types perfectly adapted for commercial purposes, so it will be possible to organize and operate air lines. Aircraft manufacturers can figure more easily today the practical prices for all kind of air transportation.

Possibility of traveling at least twice faster than on the best railway makes success a certainty. The airplane is the only means for attaining and exceeding, with safety, commercial speeds of over 100 m p h. Wealthy business men will pay high rates for such a saving of time.

The Government should organize aerial ways, signalization, special maps, landing fields and atmospheric information bureaus. Flying fields should be national property like seaharbors. The Government, which is certainly interested in aerial transportation, might give financial assistance to the first commercial aeronautic companies.

Experimentation only will show results if the benefits are sufficient to permit each manufacturer to have his own field and organization like the railway companies. At first the federal government, or municipalities, would have to organize fields, hangars, supply depots, etc. Competition is necessary for improvements. I do not think the aircraft manufacturers should join their efforts in airplane design, but they should have an agreement to use the same flying field, with a standardized signalization, under control of the Government.

The public will use air lines as soon as they are assured that this new means of transportation is perfectly safe. At first it would be best to organize a regular service of transportation with a new type of plane specially designed for that purpose. Every detail and improvement should be carefully studied in order to reduce risks to a minimum. It is also necessary that a technical commission, organized by the Government, accept this type of airplane after standardized safety tests. The same specifications should be applied to every manufacturer. It would be advisable that the test results be published, since this would assure the public of the plane's safety. Pilots of air transportation should only be accepted by the Government after very careful examinations (medical, flight, general knowledge).

The Government should conduct a central experimental aircraft establishment. It would even be very interesting if two official establishments were in competition in their aeronautical research in order to control experiments and figures. Every airplane manufacturer should have in the future his own laboratory.

In summary I will give my opinion as follows. There will be two periods in commercial aviation.

Today the Government can use military airplanes and pilots for the mail service, but that cannot result in the maximum of safety and efficiency. In order to get better conditions, airplane manufacturers will have to build different kinds of planes for the transportation of passengers and mail.

Types of Commercial Airplanes

Aerial ways being determined and landing fields located, different types of planes can be predicted.

(a) For the sport, small, light planes with special new engines of low power.

(b) For the mail-service and short distances, small, fast machines, able to show an economical operating expense.

(c) The mail service for long distances will need larger and more high-powered machines.

(d) Airplanes for passengers and mail. Passenger service might be organized by special companies or directly by the aircraft manufacturers. The same kind of plane equipped as a car should be very interesting for private use. It seems probable that wealthy people who buy very expensive yachts for cruising and sailing parties in the summer, would like to own a nice plane with a comfortable closed body, enabling them to fly for pleasure or business.

For each of these uses it is possible to build a land type or a seaplane. Types (b) and (c) should be for Government service, type (d) being operated by private companies.

Present Possibilities of Design

What can we do now? We should use the first engine in big production in this country, the Liberty, and with this engine design two types of new planes.

For land service we may expect with one Liberty engine the following characteristics:

Two pilots.

Six passengers and 300 lb. of mail.

Body will be perfectly closed and, therefore, protected against wind, cold and noise.

Three hours of fuel, full throttle, at sea level.

Maximum speed, 110 m p h, near ground.

Minimum speed, 45 m p h, near ground.

Landing gear of special design for great safety, which should make it impossible to turn over. Brakes on the wheels, for stopping quickly after wheels touch the ground, should also be provided.

Self-starter for the engine. Special exhaust manifolds with a good silencer.

Adjustable heating and ventilation.

Wireless apparatus, to be operated by one of the pilots. This will be particularly useful for receiving information about the atmospheric conditions on the air route and on the flying fields. Wireless apparatus will also be useful for sending messages informing landing fields about the next arrival of the plane.

The Commercial Seaplane

In order to travel in the big American valleys or around the lakes, it should be interesting to build a big seaplane with two Liberty engines. Large sizes, which make landing difficult, are not an obstacle with the seaplanes, so the use of two Liberty engines enables us to get a good efficiency with the following characteristics:

Two pilots.

Twenty passengers.

Six hundred pounds of mail.

Body perfectly closed, to protect passengers against wind, cold and noise.

Gasoline and oil for three or four-hour trips at about 10,000 ft.

Maximum speed, 80 m p h.

Minimum speed, 40 m p h.

Flotation by boat body made unsinkable.

Engines fitted with self-starter and special silent exhaust manifold.

Adjustable heating and ventilation.

Wireless apparatus, rockets and lighting signals.

Safety belts and small exits for light weight.

Same provisions as on the land plane for the passengers comfort.

These two planes could easily be designed by experimenting with the military planes of about the same weight and with the same engines.

Aeronautical Patents

1,278,158—To Edward S. Jones, Mobile, Ala., assignor of one-fifth to Nicholas Tate Jones, Mobile, Ala. Dirigible parachute.

1,278,253—To Stephen Szucs, Homestead, Pa., assignor of one-fifth to Emry Mike, one-fifth to Gyula Zombory, and one-fifth to Stephen Szinnyei, Homestead, Pa. Parachute.

1,278,358—To Franklin Wm. Lane, Kingston, Ontario, Canada. Airplane.

Future of the Helium Airship

By Ladislas d'Orey, M.S.A.E.

It is a curious coincidence that the Great War should have come to an end just about the time the discovery of a substitute for hydrogen as a lifting gas—an American discovery, by the way—promised to revolutionize aerial warfare. This substitute is *helium*, an inert, non-inflammable gas having approximately 92 per cent the lifting power of hydrogen; investigations made before the war show that the natural gases of Kansas, Oklahoma, Texas and Ontario contain about 1 per cent helium.

If one stops to consider that the substitution of helium for hydrogen eliminates the principal element which has put a limitation to the military and commercial use of airships, namely, the fire risk due to the inflammable nature of hydrogen, the tremendous importance of this discovery becomes apparent. The valuable properties of helium as a lifting gas have for many years been known to students of aerostation, but the mechanical difficulties and cost involved in producing this gas on an industrial basis were of such a magnitude as to almost appear beyond solution. As a matter of fact, the largest amount of helium in any one container was up to the present year only 5 cu. ft., and its cost of manufacture amounted to anything from \$1,500 to \$6,000.

British Naval Airship, North Sea Type, Flying Over H. M. S. Queen Elizabeth, at the German Naval Surrender

Central News Photo Service

How Helium Was Produced

When the United States entered the war, the British government referred to our military and naval authorities various research problems whose solution would contribute to terminate the war, among these was the industrial production of helium.

The problem was referred to the Bureau of Mines along with other war gas questions, and after investigation the Bureau of Mines requested the Joint Army and Navy Board on Rigid Airships to provide funds for the undertaking of the necessary experimental work. The Joint Board and the Aircraft Board thereupon recommended, in August, 1917, a considerable appropriation, and work was begun toward designing apparatus on entirely new lines for liquefaction of nitrogen in natural gases. This is the so-called Norton plant, which has only been in operation a few weeks.

When word was received in England that the problem of producing helium had been taken up, the British Government sent two high-ranking naval officers to this country for the purpose of requesting the American Government that all available means be employed for solving the problem.

The War and Navy Departments were not, however, satisfied that results would be obtained with the plant built along entirely new and original lines, and therefore appropriated another considerable sum to be used toward the development of plants by each of two companies operating liquid air apparatus.

The Linde Air Products Company entered into a contract for a plant about the middle of November and had the apparatus in operation on March 6, 1918, and in June had passed very satisfactory tests, as a result of which a large scale production plant is being built.

The Air Reduction Company contracted for its plant in December, 1917, and had it in operation on May 1, 1918, but the plant has not been as successful as the Linde plant. The work of design and operation has been entirely in the hands of the two companies, and present success is due to the efforts of the Linde Air Products Company.

In July a large scale production plant was recommended and in August was authorized. This plant is to follow designs of the Linde Company and will ultimately be operated by that company for the Navy Department. The construction at the plant is being done under the Bureau of Steam Engineering and by the Bureau of Yards and Docks, except for the separation apparatus, which will be furnished by the Linde Company. The buildings, to cost \$900,000, are being erected at Fort Worth, Tex., a 10-in. pipe line, 94 miles long, is now being laid at a cost of over \$1,000,000 from wells at Petrolia, Tex., for supplying the plant with natural gas, and the first production unit is expected to be in operation by April 1, 1919. Although, for quite obvious reasons, no details may now be published regarding the installation of this plant, it may be said that the helium is separated from the other components of the natural gas by the process of liquefaction of all of the gases except the helium, which can then be drawn off. This process involves the use of apparatus for creating temperatures as low as —317 deg. Fahr.

Military Aspects of Discovery

From the military viewpoint the prospects opened by the discovery of a process whereby helium may be produced in quantity and at comparatively low cost—approximately \$100 per 1,000 cu. ft.—are of a very considerable nature.

Advocates of the airship have in the past maintained that this type of aircraft would ultimately develop into an aerial battleship—a claim which the great buoyancy and steady platform afforded by the large rigid airship would have substantiated, had it not been for the inflammable nature of the gas whereby flotation was secured. Germany's disastrous Zeppelin campaign against the British Isles furnishes a striking illustration of the fact that the hydrogen filled airship does not constitute an aerial battleship, since an airplane, but one-fiftieth the cost of a large rigid airship, could by means of incendiary bullets put a Zeppelin to flight, or else bring it down in flames.

Thus, it seemed, the airship was doomed as an instrument of offense, and its use restricted to that of scouting with a fleet at sea. In this function the Germans have used their Zeppelins with marked success—particularly in the battle of Jutland, where they prevented a much greater disaster—until Great Britain developed large flying boats which met, and fought, and downed Germany's aerial leviathans. Once more the incendiary bullet had proven the vulnerability of hydrogen-filled airships.

It is therefore noteworthy that Great Britain resumed the construction of large rigid airships—which had been discontinued in 1915—as soon as assurance was forthcoming from America that the industrial production of helium was a prac-

tical possibility, what more, had the war lasted until next spring, an Anglo-American fleet of rigid helium airships would have been dispatched on a bombing campaign against Germany's strategic centers, with results which it is easy to imagine.

Indeed, with the risk of being set on fire by incendiary projectiles eliminated, the airship becomes a formidable weapon, both for long distance bombing and scouting, because its means of defense are immensely improved. Since the great buoyancy of airships will permit the mounting of small, and possibly medium, caliber defense guns, it does not seem

BRITISH NAVAL AIRSHIP R23, OF THE ZEPPELIN TYPE, FLYING OVER THE GUILDHALL OF LONDON
Central News Photo Service

likely that the attacking airplane will choose to tackle this formidable armament with machine gun fire, but will attempt to bomb its antagonist. Now, for efficient bombing work extreme high speed is rather a drawback, because it makes correct sighting problematical: it follows that in future air-ship attacks the airplane will be unable to effectually use its principal element of superiority, high speed. Defense against these aerial destroyers will thus become much easier for the airship, and the odds against it should not be any greater than those of a battleship when attacked by torpedo boat destroyers.

It is true that the large amount of gasoline carried on board airships will always expose them to the danger of being set on fire from this source, but even then this risk will be no greater than that existing on airplanes. On the other hand, the lessened vulnerability and improved means of defense made possible by the use of helium will greatly increase the offensive power of airships. Indeed, bombing raids against points several thousand miles distant will ere long become a practical possibility. In this respect the enormous load carrying capacity and hovering ability of airships obviously make of these craft an offensive instrument greatly superior to the airplane, although it should not be overlooked that their bulk constitutes an appreciable target for anti-aircraft guns, nor do airships possess the degree of maneuverability of airplanes for dodging anti-aircraft fire.

That our military and naval authorities are fully alive to the great possibilities of helium-filled airships is demonstrated by the naval appropriation bill for the fiscal year 1919-1920, in which provision is made for the construction of four Zeppelin type airships of the largest size, each to cost $1,500,000, twelve medium size airships, to cost $250,000 each, and twelve small airships, to cost $75,000 each.

Helium Airships in Air Transport

There is no gainsaying that in the field of air transport the substitution of helium for hydrogen will even exceed in importance the changes it promises to bring about in aerial warfare.

Owing to the enormous weight carrying capacity of large rigid airships (the Zeppelin L-49, which was brought down in France, had out of a total lift of 60 tons a useful load of 38 tons), these craft appear particularly suitable as long distance carriers of passengers and goods. One desires to emphasize the qualifying epithet "long distance carrier," lest foundation be given to the idea that airships will be able to compete with passenger airplanes on comparatively short distances. Such a competition seems rather out of the question because airships have not so far exceeded a speed of 65-70 m.p.h., whereas airplanes are fast approaching three that speed, although for air transport an airplane speed of about 90 m.p.h. will, mainly for reasons of economy in fuel consumption, hardly be exceeded for some time to come.

But where the large rigid airship looms up as an important means of rapid transit is on routes of several thousand miles length, such as New York London, New York San Francisco, San Francisco Tokio, New York-Panama-Buenos Aires, etc. Over such distances, with but a few ports of call a speed of 70 m.p.h. will be entirely sufficient for competing with the combined railway and steamship services, and constitute no handicap against the superior speed of the airplane because of the much greater safety and comfort afforded by the airship.

The fact that in the airship sustentation and propulsion are independent from one another is an asset which cannot be valued highly enough in the transportation of passengers, particularly on long overseas routes. Indeed, the feeling of security imparted by the knowledge that an engine failure does not necessitate a forced landing will be one of the most important factors leading to the speedy advent of travel by air. With the risk of fire eliminated, there is no reason why a rigid airship should not be made as safe as a transatlantic liner, given proper engineering skill and materials of construction. Balloon fabrics lined with goldbeater's skin have more recently been developed which lose but one-fifth of one per cent gas in 24 hours, which comes to say that an airship having its gas chambers made of this material would lose through diffusion but 6 per cent of its buoyancy in a month. These figures apply to hydrogen, and though no data are at hand in this respect regarding helium, it is stated on good authority that this gas leaks even less rapidly than hydrogen.

It should further be noted that the Germans have perfected an apparatus by means of which losses of buoyancy may be compensated for in flight; this consists essentially of a tank containing compressed hydrogen which is connected with the gas chambers, and is operated from the navigating room. Consequently it may be said without exaggeration that the modern rigid airship possesses, for all practical purposes, an almost indefinite buoyancy.

Another important point in favor of the airship is that its great weight-carrying capacity permits the use of much heavier and therefore more reliable, engines than can be fitted to airplanes. The German Maybach engine is a fitting illustration of this contention. And for the same reason passenger accommodations may be made much more comfortable than on airplanes, to which latter the great natural stability of large airships contributes in no immaterial degree.

A final point deserving emphasis is that the independent sustentation characterizing airships is likely to solve one of the most serious problems confronting the wide application of air transport, namely, that of flying and landing in foggy weather. Since fog and wind are never co-existent, a fog bound airship will be able to stop its engines, or slow them down to a safe rate of speed, without the risk of being blown out of its course; perhaps it will be compelled to float motionless for a day or two before a wind clears away the fog, just like steamships are held up by fog off a harbor. But, regardless of this inconvenience, the mere fact that the airship can stay aloft without expending fuel, and not jeopardize the safety of passengers and crew through a forced landing, constitute to one's mind such an element of insurance for safe air travel as to appeal with particular forcefulness to the conservative public.

Of course, one is quite familiar with the one great objection often made against the use of airships as carriers of passengers and goods: the very great cost, as compared to the airplane, involved in their construction as well as in the establishment of factories, airship hangars, gas generating plants, etc. This is quite a serious item, but if one considers the promising commercial future of the helium airship—which is based on solid facts, and not fancies—it does not seem as if the question of cost would be sufficiently important as to check its quick development. In fact no human enterprise was ever held up by mere considerations of cost, provided the progress to be achieved thereby warranted the expenditure.

It may also be objected to the use of airships as passenger carriers that to land them in high winds is an extremely delicate operation, one requiring very high skill on the part of both navigating and ground crews. This is readily conceded, but the same objection applies in a similar degree to the weight-carrying airplanes of large proportions, except that the airship will in all probabilities be able to stand up in a storm much longer than the airplane. In both cases highly skilled crews and properly equipped air ports are the principal insurance against untoward accidents.

Taken as a whole, the military and commercial outlook opened by the advent of the helium-filled airship are so important as to warrant one to say, without overstating the case, that a new era is opening in the history of aeronautics.

The Case for the Airship*

By W. Lockwood Marsh

Before launching into details it may be advisable to set forth the salient features of lighter-than-air and heavier-than-air craft, respectively, as I see them.

In the case of the airship the main characteristics are:

(1) Long endurance.

(2) The ability to carry heavy loads, a corollary of (1).

(3) Variation of speed.

(4) Reliability, by which is meant freedom from liability to mechanical breakdown during flight.

(5) Comfort.

(6) Security: an airship need not descend in unfavorable country even if the engines fail.

The airplane, on the other hand, bases its claims on the following points:

(1) High speed.

(2) Low cost of production and maintenance.

(3) Ease of housing.

It is unquestionably her long endurance and great weight-carrying capacity which give the airship her chief advantage over the airplane. It will, no doubt, be conceded that in spite of the stimulus of war the airship is at the present time little further advanced in development than the airplane was, say, at the beginning of 1915, and yet already airships have visited this country which could with ease fly from England to America carrying a considerable load of merchandise. A present-day Zeppelin has a gross lift of 65 tons, of which some 58 per cent is available for crew, fuel, ballast, merchandise, etc. If we take the distance across the Atlantic in a direct line as 2000 miles, we get the following disposition of our load of 38 tons:

	Tons
Crew of 30.	2.3
Ballast . . .	2.0
Gasoline	12.0
Oil	2.0
Extras (food, etc.)	1.0
Total	19.3—say 20 tons

This leaves 18 tons available for freight. These figures are based on the ship maintaining a constant speed of 50 m.p.h., at which she would do the journey in 40 hr., consuming 650 lb. of gasoline per hour.

This represents what a rigid airship of slightly over capacity can do *today*, and is given as an indication of what is possible in a comparatively early stage of development.

No one who has considered rigid airship design and studied the rapid strides which airplanes have made in the last three and a half years can doubt for a moment that an airship could be built in the course of the next two years which would have a disposable lift (or, in airplane parlance, a "useful load") of over 200 tons, giving it an endurance of anything up to three weeks at a speed of 40-45 m.p.h.

I am endeavoring to state the case as moderately as possible, and am therefore purposely putting the speed at a low figure. I believe I am correct in estimating the full speed of a modern Zeppelin at 75 m.p.h. I shall not be too optimistic in claiming 80 m.p.h. as a conservative figure for the future.

It has been stated above that the airplane is notable for its speed. This is unquestionably true of small machines of the scout type, but it is at least doubtful whether a Handley Page, for instance, can attain more than about 90 m.p.h. at the height at which it would be compelled to fly in a long overseas or cross-country journey. This only gives an advantage of 15 m.p.h. over the full speed of the rigid airship, so there is not, after all, so very much difference.

When considering the airplane as a commercial vehicle people have a happy knack of speaking glibly of speeds of 120 m.p.h. or more, ignoring the fact that speeds of this nature are only to be met with in small high-speed machines which are incapable of lifting anything beyond themselves, their crew and fuel for about eight hours' flight as an absolute maximum. That is to say, they can cover 1000 miles, but with no commercial load.

It is obviously ridiculous to consider the commercial future of a machine which is incapable of carrying a commercial load, even supposing it were able to hurtle itself through the air at the velocity of sound.

After all, an average speed of 50 m.p.h. throughout a journey is some 10 miles an hour faster than the ordinary express train and somewhere near double that of a steamship.

Which brings us to the question of the weight-carrying possibilities of the two types of aircraft in the future.

As has already been stated, the percentage of disposable lift to gross lift in a modern Zeppelin is some 58 per cent, or 38 tons.

In an airship the capacity, and therefore the gross lift, increases as the cube of the dimensions, so that a comparatively small increase in size is accompanied by an enormous gain in lift, while the resulting increase in the weight of the structure is nothing like proportional. In fact, in the case of military airships a really big ship—say of 10,000,000 cu. ft. capacity—would unquestionably have something approaching 70 per cent of its gross lift available for crew, fuel, freight, etc. A commercial airship would undoubtedly have a heavier framework for various reasons, but there is little doubt that 60 per cent is by no means an optimistic figure.

In the case of an airplane, on the other hand, the gain in gross lift is theoretically only proportional to the increase in area, and even that is optimistic. Every foot of span added to an airplane means not only the additional weight of the extra material, but necessitates adding proportionately to the weight of previous spans to give the necessary strength to resist the increased bending moment, with the result that a time arrives when any further increase will actually result in a loss, instead of a gain, in lift.

This limit is put by Mr. Lanchester at about 160 ft., and even if this figure be pessimistic the principle remains the same.

Another way of looking at this point is that in airship and airplane alike the weight increases in direct proportion to the superficial area, the strength being inversely proportional to the linear dimensions. Where the airship has the advantage

* Courtesy of *Aeronautics*

is that the lifting power increases with the cube of the dimensions, while in the airplane only with the square

The load-carrying efficiency (percentage of useful load to gross lift) of a large airplane is little, if any, more than that of a small scout—about 33 per cent—as compared with the 58 per cent of a present day rigid airship. Added to that is the fact just stated, that the airship gains in such efficiency by increase in size while the airplane does not.

Paradoxical as it may seem at first sight, speed is another factor in which the big airship has a relative advantage over the large airplane.

The Zeppelins of the beginning of the war had a speed of some 45 m.p.h., with a capacity of 1,000,000 cu. ft. The modern Zeppelin, of a little over 2,000,000 cu. ft., attains 75 m.p.h.

On the other side of the picture we have a scout airplane with a speed of about 150 m.p.h., as against the 90 m.p.h. of the large bomber.

This is the practical demonstration of the theoretical truth that in the airship increase in size can be, and is, accompanied by increase in speed, while the reverse is the case with the airplane.

It can be proved that with an airship the resistance is proportioned to $W^{1/6}$, whereas in an airplane it is proportioned to W—W, being the gross lift (gross weight when fully loaded) in each case, which is the mathematical method of stating the same fact.

Another point to be considered in this connection is the inherent characteristic of the heavier-than-air type that a considerable portion of the power is expended merely in enabling the machine to fly, while in the airship the whole thrust is devoted to the attainment of speed.

In fact, it is probably true to say that an airplane of the same weight-carrying capacity as a modern rigid airship would actually be slower.

We in the aeronautical world are indebted to Mr. Lanchester for pointing out that one of the best methods of comparing the efficiency of different methods of transport is to take the resistance (or thrust required) as a percentage of the total weight, which gives what is known as the coefficient of tractive resistance. Mr. Lanchester, in his book "The Flying Machine from an Engineering Standpoint," gives the following figures for motor vehicles, railway trains, cargo boats and airplanes, respectively—to which I have added that of a 60-ton airship at a speed of 60 m.p.h.

Coefficients of Tractive Resistance

	Per cent
Solid rubber-tired motor vehicles	3.00
Railway trains (normally)	1.00
12-knot cargo boat	0.25
Airplane	15.00
Airship	4.00

It may be added as an example of the advantage of an airship's ability to reduce its speed that the coefficient of tractive resistance of the same airship at 45 m.p.h. falls to 1.92 per cent, or less than that of a motor-car.

Again, if we double the volume of our airship (which only means a 20 per cent increase in dimensions), the tractive resistance coefficient at 60 m.p.h. is only 2.72 per cent, while at 45 m.p.h. it in this case is as low as 1.36 per cent—very little more than that of a railway train.

If we go a step further and consider a 10,000,000 cu. ft. rigid airship, having a disposable lift of some 200 tons, with the same coefficient as the 60-ton airship at 60 m.p.h., she would have a speed of 80 m.p.h.

Those who decry the airship frequently scoff at the number of men required to handle one of these craft when landing or getting away, but they forget the amount of tuning up that a large airplane constantly requires, necessitating the employment of quite a surprisingly large body of skilled mechanics. Besides, one has seen pictures of large airplanes—though it is true they actually land without outside assistance—being returned to their sheds with the aid of motor tractors or a squad of men numbering at least twenty. Assuming that a rigid airship needs ten times this number, its useful load-carrying capacity is 38 tons as against the 2 tons of the airplane, which one fancies works out favorably to the airship in pounds of commercial load per man employed. In this connection one would like to see published the hours of flying carried out per man employed in the Airship Service as compared with airplanes during the present war.*

Earlier in this article low cost of production has been set down as one of the points in favor of the airplane, but it must not be forgotten that there is relativity in all things. The correct way to look at this is to consider the cost per pound of commercial loads carried—as in the case of man power.

It is difficult to get figures, but if $500,000 be taken as the cost of a 60-ton airship having a disposable lift of 38 tons, and $30,000 as the price of a 5-ton airplane with a useful load of 2 tons, probably neither disparagement nor undue advantage will be given to either. Curiously enough, this comes out at approximately the same sum ($6.60) per pound of commercial load carried in each case. But it would take nineteen of the airplanes to do the work of one rigid airship, and each of them would only be able to cover a maximum of about 900 miles as against the 2000 miles of the airship. So, as a commercial proposition, I fancy the airship would have the pull.

Maintenance costs it is unfortunately impossible to estimate even approximately, though the airplane will probably have some advantage here, but whether that advantage would be maintained if the sum were worked out on the principle of cost of commercial load *per mile* is an interesting problem which only a practical trial can solve.

Having dealt with the more theoretical side of the case, I now propose to put forward the peaceful uses to which the airship could be put. Up to the present I have been dealing mainly with the rigid type, though, of course, the main principles are equally applicable to the non-rigid and semi-rigid classes of airship.

From the purely pleasure point of view the airship has many advantages over the airplane, as I think most people who have had experience of both types will agree.

In the first place, to the mind of the novice there is unquestionably a feeling of security—far be it from me to say whether real or only imaginary—about having a comfortable "gas bag" above the head. It has the disadvantage of keeping off the sun, but otherwise gives the sense of very present help in time of trouble—as ran the schoolboy's definition of a lie.

Then there is the question of comfort. No one can deny that the accommodation in even a large airplane is, to say the least, cramped. Now in quite a moderate sized non-rigid airship of about 400,000 cu. ft. there is ample head-room for a straight walk of 20-30 ft. from end to end of the car, and in the large rigid airship there is not only plenty of space in the gondola, but one can, if one so desires, take a walk in the keel of 400 or 500 ft. in length.

Another point in which the airship gains is in her ability to cruise at low heights. To insure a modicum of safety in landing in the event of engine failure, an airplane is compelled to fly at a height of at least 5000 ft., if not higher. Apart from the obvious joy of getting up into the sunshine on a day of low lying clouds, the most pleasurable height for aerial cruising is undoubtedly between 500 to 1000 ft., at which height one gets a wholly delightful perspective view of the countryside. Here again the psychological—or should it be physiological?—aspect of flying comes in, as to many people the idea of being at great heights above the ground inspires feelings of discomfort, if not terror. There is a strong feeling of loneliness and separation from human intercourse when sitting in the cockpit of an airplane at big heights which is most unnerving to the novice, however ridiculous it may seem to the hardened aviator.

The ideal pleasure craft for the wealthy man of the future would be a non-rigid airship of about 100,000 cu. ft. capacity with a comfortable totally enclosed four seater car, driven by two engines of some 100 hp. each. This would have a full speed of about 60-65 m.p.h., with an endurance of 15 or 16

* A semi-official statement on the work of the British Airship Service during the war, which has been issued by the British Air Ministry since this article was written, shows that the author is correct in his assumption that airships are more economical in man power than heavier-than-air craft. The figures given show that airships employed 1.62 men per hour flown, as against 3.52 for airplanes and seaplanes, and flew 1.04 hours per man employed, as against 0.40 for airplanes and seaplanes. In other words airships employed only 42 per cent the personnel required by heavier-than-air craft for flights of equal duration.—*Editor*

hours, but would be at its best when jogging along at about 45 m.p.h., which it could do for about 24 hours. The cost would be considerably less than that of a yacht, and in moderate weather the ship could be moored out under the lee of a belt of trees or even to a buoy on the water.

Then there is the non-rigid of about 500,000 cu. ft. capacity, necessitating a crew of five or six and carrying ten or a dozen passengers, with a large roomy car with facilities for cooking and even sleeping accommodation. The two engines, totaling about 600 hp., would be so far removed and well silenced as to be scarcely noticeable. The speed would be about 65-70 m.p.h., and the endurance 24 hr. or so at full speed and about 2½ days at 45 m.p.h.

The possibilities of non-rigid airships larger than this are difficult to set out, as there is little or no experience to guide one, but there is little doubt that a ship of some 800,000 cu. ft. capacity could be built, which should be able to carry 20 or 30 passengers, having a full speed of about 70 m.p.h., which it could maintain for two days or more, the endurance at 45 m.p.h. being probably in the neighborhood of five or six days. This ship would be able to cross the Atlantic.

To leave the non-rigid, the rigid airship has of course, endless possibilities, both as a passenger vehicle and for commercial transport.

A present-day Zeppelin could carry some 18 tons of freight across to America, and the really big ship—it must be remembered that up to the present we have been talking of lighter than air midgets—could transport at least 150 tons the same distance.

This ship would, of course, be built on some simple method of steel construction in place of the somewhat flimsy and complicated built-up girders of duralumin at present used, and her outer cover would be something almost in the nature of coarse canvas, thoroughly waterproof, so that she would be able to live entirely in the open, with the result that she could take the air in practically any weather.

The most suitable commercial routes for airships would be those requiring a non-stop run of upwards of 1000 miles, involving at present both sea and land transit, as the cost and delay of transshipment would be avoided.

Airship routes could be run to India via Alexandria and the Red Sea, to Australia via Cape Town, and thence to New Zealand, besides many others which suggest themselves.

A shed would not be required at more frequent intervals than about every 2000 miles, intermediate stopping places (if required) consisting merely of a landing ground with mooring blocks or a mooring mast, and facilities for replenishing with fuel or hydrogen.

If it were not desired to stop, passengers or mails could be delivered and collected by means of airplanes carried on the underside of the airship and slipped as required.

In addition to these, there are many other uses for the airship in peace.

They form an ideal method of making a photographic survey of unexplored territory—proper plans being subsequently drawn from the photographs. The airship could work in conjunction with a land exploration party, keeping the latter in touch with civilization, which would enormously improve the morale, and supplying them with food by means of parachutes.

In police work in outlying portions of the Empire the airship also could fill a useful role. Punitive expeditions on raiding tribes could be carried out almost without the necessity for using armed forces, as a load of bombs, scientifically distributed among their villages should bring the hardiest savages to their knees.

This article, it may be said in conclusion, is not meant to decry the uses of the airplane for short distance mail-carrying over routes where high speed is essential, or for other similar work, but it is intended to draw attention to the fact that there is another class of aircraft which, owing to its very different characteristics, has other uses no less important, and certainly very far from negligible.

Naval Flying Boat NC-1

Now that all restrictions on military news have been lifted by the government, it is possible to reveal some details of the naval flying boat NC-1, which is one of the largest machines of its class ever built and flown.

The NC-1, familiarly known in the Naval service as the Nancy 1, was built by the Curtiss Engineering Corp., Garden City, L. I., to the designs of the Bureau of Construction and Repair of the Navy Department, Naval Constructors Hunsaker, Richardson, and Westervelt being chiefly responsible for its

Three-Quarter Front View of the NC-1 Naval Flying Boat
Central News Photo Service

design. Constructed during the war, it was to be a submarine chaser mounting powerful armament; its proportions are therefore very impressive.

The Nancy-1 has a maximum span of 126 ft. and an overall length of 70 ft., the chord and gap of the wings are both 12 ft., and the overall height, measured from the keel to the gunner's cockpit on the upper wings, is 25 ft.

The power plant consists of three low-compression (Navy type) Liberty engines, developing about 350 hp. each, which are mounted between the wings in special nacelles, and actuate four-bladed tractor airscrews by direct drive. The maximum speed of the Nancy-1 is about 80 m.p.h., and in recent trials an altitude of 2,000 ft. has been reached in 10 min. Sufficient fuel and oil is carried on board to give the machine an endurance of 13 hr. The fuel tanks hold 300 gal.

The gross weight of the machine, that is, fully loaded, is 22,000 lb., and the net weight, 13,000 lb., the useful load thus amounts to about 4½ tons. The crew consists normally of five officers and men, two of whom are pilots and sit side-by-side in a cockpit provided with dual control. A gunner's cockpit is fitted in the nose of the machine, and another is mounted in the middle of the upper wing; access is had to the latter, which is not shown in the accompanying illustration, by means of a vertical ladder.

The great possibilities a machine of this type holds forth for air transport were strikingly demonstrated on Nov. 8, 1918, when the Nancy-1 flew with its crew of five and ten passengers from New York to Washington, whence it proceeded the same day to the naval air station at Hampton Roads, Va. On Nov. 27 the same machine carried aloft, beside its crew of five, forty-five passengers at the naval air station at Rockaway, N. Y. In both flights Lieut. David H. McCullough, U. S. N., was piloting the machine.

British Official Report on Air Transport

The report of the British Civil Aerial Transport Committee, which was presented to the Air Council nearly six months ago, has now been presented to Parliament, but apparently it will not be printed until Parliament sits again in the New Year. In its issue of November 25 the London *Times* foreshadowed the lines of the report as follows.

The original reference was to consider

(1) The steps which should be taken with a view to the development and regulation after the war of aviation for civil and commercial purposes, from a domestic, an Imperial, and an international standpoint

(2) The extent to which it will be possible to utilize for the above purpose the trained personnel of the aircraft, which the conclusion of peace may leave surplus to the requirements of the Naval and Military Air Services of the United Kingdom and Overseas Dominions.

Composition of Committee

The Committee, which has undergone some changes since its appointment in May last year, was a large and representative one. It included Sir Richard Glazebrook, F.R.S., Mr. G. Holt Thomas, Mr. Claude Johnson, Mr. F. W. Lanchester, Mr. T. Sopwith, Lieut.-Col. M. O'Gorman, Mr. J. D. Siddeley, Maj.-Gen. R. M. Ruck, C.B., Mr. H. G. Wells, Mr. Butler Aspinall, K.C., Mr. Balfour Browne, K.C., Brig.-Gen. Brancker, R.F.C., Capt. Vyvyan, R.N.A.S., Col. J. W. Pringle (Board of Trade), Sir Mackenzie Chalmers (Home Office), Sir Laurence Guillemard (Board of Customs and Excise), Mr. G. E. P. Murray (Post Office), Mr. G. E. A. Grindle (Colonial Office), the Duke of Atholl, Lord Sydenham, Lord Montagu of Beaulieu, the Earl of Drogheda (Foreign Office), Mr. Joynson-Hicks, M.P., Mr. Tyson Wilson, M.P., Mr. A. E. Berriman, Mr. G. B. Cockburn, Mr. H. White Smith, and representatives of all the self-governing Dominions. Lord Northcliffe, who was the original chairman, had time only to preside at the first meeting before he left for the United States as head of the British War Mission. Major Baird, M.P., was the deputy-chairman.

Terms of Reference of No. 1 Committee

It was soon found that the Committee was far too large, and accordingly it divided into several special committees, the most important perhaps being No. 1, under the chairmanship of Lord Sydenham, whose task was to advise on policy and necessary legislation, with special reference to

(1) The attitude to be adopted by the State with regard to national sovereignty in the air and international questions connected with aerial transport

(2) The question of State ownership (if any) or of necessary State control and regulations of Customs, quarantine, and aliens.

(3) Necessary amendment of the common and statute law as to the air covering private property, and as to compulsory purchase of land for aerodromes and landing grounds

(4) The principles of liability for damage caused by or to aircraft.

Sovereignty of the Air

These questions raised at once the initial difficulty of the sovereignty of the air, that is to say, whether the old doctrine that the owner of a piece of land possessed rights *usque ad coelum* existed up to the present moment and should exist for all time. This question had been discussed as an international one when a convention sat in Paris in order to deal with the rights of international aviation, and that convention failed largely over this question, the Germans holding that it was idle to restrict the right of flying over private lands and claiming "the freedom of the air" in a sense which would allow of machines flying, for example, over Portsmouth Harbor. The British delegates, on the contrary, having in view, perhaps, what afterwards occurred, took the contrary view, and held that there must be sovereign rights in any State to control the passage and use of its own air. The Committee came to the conclusion that in any legislation there must be an assertion of the "sovereignty and rightful jurisdiction of the Crown over the air superincumbent on all parts of His Majesty's Dominions and the territorial waters adjacent thereto." They added that, in their opinion, the ordinary three-mile limit of territorial waters would not be sufficient for what may be called "territorial air," and they redrafted the original International Convention for submission to the Foreign Office, and, it is hoped, for the consideration of another conference to be called shortly. It is regarded as of the highest importance that this conference should be called immediately. At present there are no regulations governing flying on the Continent or foreign flying here. Methods of identification, of inspection, of passports, of Customs, the provision of landing stages, and the thousand and one matters which require consideration and settlement in regard to the new method of transport are still unsettled, and whether or not Germany takes part in the conference, it is essential, in order that the change from military to civil aviation should not be delayed and complicated, that the conference should get to work at once.

Ownership of the Air

Committee No. 1 also drafted the clauses of an Aerial Navigation Bill dealing with such points as the qualifications for owning aircraft, registration, certificates of airworthiness, certificates of officers, regulations dealing with collisions, identifications, papers, signals, Customs, and the Post Office.

The other important question which came before the Committee was the ownership of air by the individual landowner, and the Committee came to the conclusion that no action for trespass should lie, except for material damage, but that a right of action for trespass should include one for injury caused by the assembly of persons on the landing or ascent of aircraft elsewhere than at authorized aerodromes, and in an action for trespass the obligation on the aviator should be absolute, it not being necessary to prove negligence against him. Under the present law grave damage may be caused to a man or his property by a moving vehicle without any right of redress. If, for instance, a man is run over in the street by a motor-omnibus, he cannot obtain damages unless he proves that the driver was in some way negligent. But the Committee felt that in the case of a machine falling from the skies killing or injuring either the landowner or, say, his poultry, it would be impossible to prove negligence on the part of the airman, and that accordingly in such a case the actual machine causing the damage should be responsible, even though the fall might be caused by collision with another machine whose pilot was the guilty party.

Commercial Transport

The second Special Committee dealt with the scientific and technical side of aeronautics with a view to ascertaining what could be done in commercial transport by the then existing machines, and they took as their standards four machines—the Handley-Page, the de Havilland, the R.E.8, and the Sopwith "Pup."

The Committee arrived at six definite conclusions about airplanes, as follows

(1) That for commercial success speed is probably the most material factor

(2) That for commercial success the speed needed depends very largely on the conditions of competing methods. Between large centers connected by direct high speed railways, speeds of 100 miles per hour are desirable, but for linking places between which the railway service is slow or interrupted by sea crossings, lower speeds will be found commercially practicable

(3) That at present stages of about 500 miles would be the normal limit, but that it will be desirable from the commercial point of view that stages should be as long as possible.

(4) That it is desirable as speedily as possible to develop the existing facilities for night flying, especially for the carriage of mails

(5) That heavy loading is necessary for commercial success, but since this will involve a high landing speed, development of land and air brakes is necessary

(6) That in view of certain disadvantages of high landing speed, efforts should be made to keep loading as low as

possible consistently with securing a commercial rate of speed, and to provide for aerodromes and landing places possessing the best possible surfaces, and that it may well be hoped that future inventions and improvements in design will enable a lower landing speed to be attained without sacrifice of flying speed

Future Developments

The Committee also had to consider whether there was a possibility of unexpected inventions modifying the lines of present development, but they came to the conclusion that this was not so, and that while there would be considerable development in the existing appliances for flying there was no prospect of more than quantitative modifications of existing conditions. The existing airplane will be improved. Such things as folding wings, already used in the Handley-Page machine, will no doubt be increased, and an all-round improvement in engines is still certain to come. A very great improvement has taken place, in fact, since the Committee sat.

State Encouragement

The Committee felt that every effort should be made by State aid or State encouragement to widen the basis of fuel production and to prevent the great interests both of aerial navigation and of automobilism being dependent on fuel of any one kind, particularly if it comes from overseas. The importance of this point has been emphasized during the recent war, in which the civilian consumption of gasoline has been so severely restricted. The Committee also considered at great length definite air routes, such as from London to Edinburgh, Glasgow, Dublin, the Riviera, Russia, and South Africa.

Provision of Aerodromes

The mere provision of airplanes is a small part of the question of commercial aviation. The provision of aerodromes and landing stages is urgently needed, and without compulsory powers of purchase, of course, is more difficult. The whole question of landing grounds, in regard to which the military side of aviation has afforded ample experience, had to be considered, and the Committee concluded that landing grounds should

(1) Bear some reference to the direction of the main aerial routes,

(2) Be sufficiently far from the centers of cities to be fairly clear of houses in the direction of flight

(3) Be unlikely to be shut in by buildings in the immediate future

(4) Be as far as possible clear of railways, telegraphs, trees, and other obstructions

(5) Be situated on ground as far as possible free from mist or fogs.

(6) Be provided with adequate water supply, telephone connections, and good facilities for rail, tram, omnibus, and motor traffic with the different districts of the cities to be visited;

(7) Be capable of expansion.

Advantages of Aircraft

The Second Committee also came to the conclusion that the use of aircraft would be advantageous

(1) In the case of mails, by competing with the telegraph service, or by establishing a new type of express letter service,

(2) In the case of passengers, by affording rapid transit over long distances, particularly where the journey includes a sea crossing, and

(3) By enabling ordinary merchandise, commercial samples, etc., to be carried more rapidly than by any other means.

The Committee, however, came to the conclusion that probably one of the first methods of employing airplanes for the transport of passengers might lie, not in a regular service, but in the occasional and increasing use of single machines for rapid journeys.

Work of Other Committees

The third, fourth, and fifth special committees were of a more technical character. The third dealing with production throughout the Empire of the necessary types of aircraft for organized aerial services, the fourth with the possibility of setting up a model type of industrial organization applicable to the whole of the labor employed in aircraft manufacture and transport, and the fifth with aeronautical inventions and experiments, research in regard to meteorology, and investigation of accidents.

Position of the State

One question was discussed in several of the committees and in the Main Committee, which will have to be settled by Parliament—namely, whether commercial flying is to be undertaken as a big experiment in State Socialism, or whether it is to be intrusted to individual enterprise, supplemented, so far as landing stages are concerned, by the assistance of the existing military organization or the exercise by the State of compulsory power of purchase. Some members of the Committee were obviously inclined to favor a State experiment, but Committee No. 1, presided over by Lord Sydenham, reported in favor of State encouragement of private enterprise, and against what may be called a State Socialistic experiment. It is claimed by many that the new industry should be as free from State control as possible. A private firm, it is urged, can properly risk its capital in exploiting a promising new invention or development, but a State department would be in the position of a trustee, would think twice or thrice before risking the necessary funds, and would be responsible to Parliament for its action. During the war the Air Council has admittedly made bold experiments, but it is pointed out that in so doing the Department has been untrammeled by Parliament, and has been free to incur an expense unthinkable in peace time.

Three-Engined Caproni Biplane
(C) *Press Illustrating Service*

Performance and Cost of the Air Mail Service

Reports on the performance of the Air Mail Service during the month of November, and on the cost of operation and maintenance in October, have been issued by Second Assistant Postmaster Otto Praeger, and are printed herewith.

Some considerable changes have recently taken place in the Air Mail Service, one among these being the resignation of Capt. B. B. Lipsner, superintendent of the service, and a general reorganization of the staff work. Two sections have been created, one on flying operations, and the other on maintenance and equipment. Lieut. J. C. Edgerton, who had been one of the postal aviators while the service was operated by the War Department, has resigned from the Army to take charge of the Section on Flying Operations. Dr. L. T. Bussler, who served on General Pershing's staff in Mexico, and subsequently as adjutant and instructor to the West Virginia Flying Corps Unit, which went to France, has been appointed Chief of the Maintenance and Equipment Section.

PERFORMANCE OF AVIATORS, NOVEMBER, 1918

Total possible number of flights	104
Total possible mileage	11,3[illegible]
Total perfect (uninterrupted) flights made	102
Total interrupted flights made	2

Pilot	Perfect Flights No.	Perfect Flights Miles	Forced Landings: Interrupted Flights	Forced Landings: Uncompleted Flights	Total No.	Total Miles
Dana C. DeHart	28	3,032	0	0	28	3,032
Robt. F. Shank	16	1,744	0	0	16	1,744
Max Miller	32	3,488	0	0	32	3,488
Edw. V. Gardner	12	1,308	0	2	14	1,526
Louis Lipton	4	430	0	0	4	430
Lawton V. Smith	10	1,090	0	0	10	1,090
Total	102	11,118	0	2	104	11,3[illegible]

SERVICE AND UNIT COST, OCTOBER, 1918

Airplane No.	Gall. of Gas.	Total Time Run Hr.	Total Time Run Min.	Total Miles Run	Miles Run per Gallon of Gas	Cost per Hour	Cost per Mile
1	411	36	33	2,630	6.39	$20.70	$0.4100
2	451	38	13	2,974	6.54	29.85	.3880
4	488	70	51	2,964	6.07	41.81	.4270
5	175	24	34	894	5.10	42.38	1.1921
6	295	20	46	1,452	4.92	47.11	.6738
38262	18						
38274	241	17	50	1,190	4.93	45.00	.6743
38275	45	2	09	189	4.10	290.05	3.5847
38278	42	7	08	320	7.61	192.21	1.8820
38365	60						
38366	87*	0	78	87	1.20	574.54	6.6017
Total	2,291	184	02	12,671	5.52	$53.48	$0.7767

* Leakage

AIR MAIL OPERATION, NOVEMBER, 1918

Date, 1918, November	Miles Flown (1)	Hours of Flying Hrs. (2)	Hours of Flying Min. (2)	Mail Carried A (3)	Mail Carried B (3)	Per Cent of Performance (4)	Arrival Wash.	Arrival N. Y.
1	436	5	58	26½	600	100	4.30	2.25
2	436	5	54	48	909	100	3.37	2.46
4	436	6	03	50	872	100	3.54	2.16
5	436	5	37	22½	631	100	2.52	2.50
6	436	5	40	41	808	100	2.48	2.32
7	436	5	50	35	598	100	3.00	2.56
8	436	7	01	35½	805	100	2.45	3.05
9	436	6	32	44	575	100	4.10	2.26
11	436	7	38	41	444	100	3.01	2.56
12	436	7	18	31½	578	100	2.43	3.06
13	764	7	14	20½	660	100	3.10	2.46
14	436	7	44	30	567	100	2.46	2.30
15	436	5	34	31½	680½	100	3.40	1.55
16	436	6	20	30½	907	100	4.12	3.05
18	218	3	04	31	920	50	11.25 p.m.	2.30
19	436	5	71	35	652	100	4.00	2.06
20	436	6	44	34½	305	100	4.25	2.46
21	436	6	31	20½	582	100	3.47	2.40
22	436	5	48	35½	626	100	3.28	2.25
23	654	6	18	38	821	100	4.17	3.08
25	872	12	30	30½	1,238½	100	4.01	2.42
26	872	8	46	34	897½	100	3.21	2.53
27	436	6	49	30	824	100	4.06	2.50
28	436	7	21	31½	508	100	3.26	2.47
29	436	7	24	28	615	100	3.46	1.09
30	436	6	02	41	621	100	4.32	1.50
	12,101	184	00	887	18,068½			

Note.—No. hours of dead flying for the month, 10 hrs. 41 min.

EXPLANATION OF TABULATION

1. *Miles flown*
   Leg from Washington to Philadelphia 128 miles
   Leg from Philadelphia to New York 90 miles

Miles flown for the day whether one, two, three or four legs of the trip have been made.

The aim is to get exactly the number of miles flown in connection with the mail service each day. Therefore mileage of partial trips should be indicated.

2. *Hours of flying*
   To include the actual hours and minutes the machine is in the air with mail.

3. *Mail carried*
   In this column, under A, give pounds of aeroplane mail, and under B give pounds of ordinary mail.

4. *Per cent of performance*
   Round trip Washington-New York consists of four legs, each leg valued at 25 per cent if completed by aeroplane and not by train before close of day.

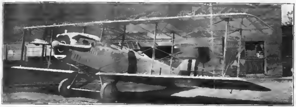
COST OF OPERATION AND MAINTENANCE, OCTOBER, 1918

Airplane No.	Gas.	Grease and Oil	Office Force	Motor Cycles, Trucks, Fuel	Rent, Light, Power, Telephone and Water	Miscellaneous	Pilots—Actual Time	Mechanics and Helpers: On Plane	Mechanics and Helpers: Shop Time	Repairs and Accessories	Interest on Investment	Departmental Overhead Charge	Total
1	$130.28	$26.75	$39.50	$31.33	$39.55	$61.25	$241.55	$187.61	$40.88	$64.40	$101.97	$113.49	$1,078.51
2	137.00	44.91	39.50	31.32	39.55	61.26	252.50	191.00	40.88	79.93	101.97	113.49	1,133.34
4	148.38	37.37	39.50	31.32	39.55	61.26	263.28	196.80	40.88	194.85	101.67	113.49	1,281.85
5	53.00	12.21	39.50	31.32	39.55	61.26	182.30	207.30	40.88	203.00	101.98	113.48	1,085.79
6	90.05	22.10	39.50	31.32	39.55	61.26	197.25	163.37	40.88	187.57	101.98	113.49	978.40
38262	5.58	2.20	39.50	31.32	39.55	61.26		72.56	40.87	780.39	101.98	113.48	1,288.67
38274	73.40	14.82	39.50	31.32	39.55	61.26	117.85	140.41	40.87	27.99	101.48	113.48	802.59
38275	13.50	2.81	39.50	31.32	39.55	61.26	14.23	114.25	40.87	72.31	101.98	113.48	644.30
38278	12.87	5.35	39.50	31.32	39.55	61.26	20.75	148.31	40.87	5.00	101.98	113.48	602.29
38365	19.50		39.50	31.32	39.55	61.26		12.40	40.87	14.40	101.98	113.48	474.26
38366	20.10		39.50	31.32	39.55	61.26	6.40	64.67	40.87	36.25	101.98	113.48	555.36
	$703.67	$168.32	$434.50	$344.51	$435.12	$673.85	$1,210.17	$1,490.03	$449.62	$1,567.03	$1,121.75	$1,248.33	$9,841.76

STANDARD BUILT DH-4-L POSTAL AIRPLANE, WITH LIBERTY 12 ENGINE

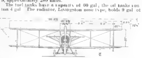
The Standard Single-Seater Mailplane

The Standard single-seater mailplane is a tractor biplane of 31 ft. 4 in. span and 26 ft. 7 in. overall length, and is fitted with a model I Hispano-Suiza engine, which develops 170 hp. at 1,700 r.p.m. The machine has a horizontal speed, near the ground, of 100 m.p.h., and climbs 5,300 ft. in 10 min., and 10,000 ft. in 24 min. Its best gliding angle is 1 in 8, and its maximum endurance, 3 hours at 5,000 ft., at full speed, that is, approximately 280 miles.



A STANDARD POSTAL AIRPLANE WITH 150 HP. SIMPLEX HISPANO ENGINE

The fuel tanks have a capacity of 60 gal.; the oil tanks contain 4 gal. The radiator, Livingston nose type, holds 9 gal. of water. The mail compartment is situated in front of pilot's cockpit.



FRONT ELEVATION

The machine weighs fully loaded 2,450 lb., with overhang, and has a normal mail carrying capacity of 180 lb. The wing loading is 7.12 lb. per sq. ft., and the power loading, 14.1 lb. per hp.

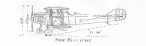
A detailed itemization of the general characteristics follows.

Main Dimensions

Overall length	26 ft. 7 in.
Overall height	10 ft. 10 5/16 in.
Wing section employed	R. A. F. 15
Area of upper wing	[illegible] sq. ft.
Area of lower wing	[illegible] sq. ft.
Total wing area including ailerons	[illegible] sq. ft.
Span upper wing	31 ft. 4 in.
Chord upper wing	[illegible]
Aspect ratio upper wing	[illegible]
Span lower wing	[illegible]
Chord lower wing	[illegible]
Aspect ratio lower wing	[illegible]
Gap	[illegible]
Stagger in inches	[illegible]
Sweepback in degrees	[illegible]
Dihedral	1 per cent
Decalage in degrees	[illegible]
Angle of lower wing chord to propeller axis	½ deg.
Height of axis of propeller above ground with	
1. Machine, resting on ground	5 ft.
2. Propeller axis in line of flight	5 ft.
Angle between line from axle of wheel to C. G. with a vertical line when machine is horizontal	14 deg.
Angle between line joining wheel base and skid to a horizontal line	11 deg. 30 min.
Stabilizer setting to lower wing chord	0 deg.

Areas of Control System

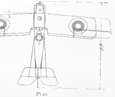
Aileron area, lower wing	24 sq. ft., unbalanced
Aileron area, upper wing	24 sq. ft., unbalanced
Area of stabilizer	23.7 sq. ft.
Area of elevators	22 sq. ft., unbalanced
Area of fixed fin	4.6 sq. ft.
Area of rudder	10.1 sq. ft., unbalanced



SIDE ELEVATION

Weight Schedule

	Pounds
(a) *Power Plant*	
Engine complete with carburetor and ignition system	475
Radiator	74.5
Radiator and engine water	75
Fuel tank empty	50
Oil tank empty	[illegible]
Propeller and propeller hubs	[illegible]
Cowling	61.5
Pipes, etc.	35
Total	715.5
(b) *Fuel and Oil*	
Fuel (60 gallons)	360
Oil (4 gallons)	30
Total	390



PLAN

(c) *Passengers and Miscellaneous Equipment*	
Pilot and clothing	170
Dashboard instruments	32.28
Miscellaneous	62
Total	264.31

Mail Compartment of the Standard Mailplane

(d) *Mail*	
Total	180
(e) *Body*	
Body frame	218
Engine bed	14
Seats and floor	31.8
Front and rear control	7.75
Total	288.1
(f) *Tail Surfaces with Bracing*	
Stabilizer	24
Elevators	17.8
Fin	3
Rudder	9.5
T. S. fittings, wires, etc.	21.5
Total	75.8
(g) *Wing Structure*	
Upper wing with fittings and aileron	143.5
Lower wing with fittings and aileron	129.5
Interplane struts and cables	51
Total	324
(h) *Chassis*	
Weight of wheels complete	
Weight of axle	88
Weight of shock absorber	
Weight of miscellaneous parts	
Total	90
Three wheel type landing gear	25 extra
Total	121

Summation of Weights

Group	Weight	Percentage of Gross Weight
(a) Power Plant	778.5 lb.	32.4
(b) Fuel and oil	390 lb.	16.2
(c) Passengers and Miscellaneous Equipment	264.3 lb.	11.0
(d) Mail	180. lb.	7.5
(e) Body Structure	288.1 lb.	12
(f) Tail Surfaces with Bracing	75.8 lb.	3.2
(g) Wing Structure	324 lb.	13.5
(h) Chassis	100.8 lb.	4.2
	2400 lb.	100.

Equipped with Overhang Section

Area main planes	382.4 sq. ft.
Area upper plane with aileron	229.3 sq. ft.
Area lower plane with aileron	102.1 sq. ft.
Area upper aileron (2)	28 sq. ft.
Area lower aileron (2)	24 sq. ft.

The Curtiss R-4-L Mailplane

The first airplanes to be used in the New York-Chicago air mail service typify the transition which the United States is making from war to peace and illustrate what is being done to turn aeronautics from military to commercial pursuits. The plane first to start to Chicago from Belmont Park was a Curtiss R-4-L model. This machine is a remodeled type of the Curtiss R-4, which was the airplane first used by the United States Army in carrying mail from the Texas frontier to General Pershing's Expeditionary Forces in Mexico. Experience gained in this work enabled the Curtiss Engineering Corp. to develop a flying machine for reconnaissance work, and this plane, the R-4-L, was constructed while we were at war with Germany.

The Curtiss R-4-L has a wing spread of 48 ft. It is equipped with one Liberty engine, and has a flying speed ranging from 100 to 135 m.p.h.; its landing speed is 50 m.p.h.

Regarding this machine Glenn H. Curtiss recently said:

"In the Curtiss R-4-L we have taken what we believe to be the first step in utilizing war equipment. The Curtiss R-4-L is a two-place machine. Our designers have altered the first cockpit and have transformed it into a mail compartment which contains between 33 and 35 cu. ft. of space and can carry about 625 lb. of mail. The pilot's seat and equipment have been removed and a steel cover, resembling somewhat the hood of an automobile, has been installed. It will be necessary to develop a more commodious and compact mail compartment suitable to postal needs and the industry is now working out this problem."

A Curtiss R-4-L Mailplane, with Liberty 12 Engine

The Future of Airplane Photography

By Arthur Brock, Jr., and L. J. R. Holst

The commercial future of airplane photography is not generally appreciated by airplane builders, since they have not as yet realized that preliminary surveying of highroads, railroad and other through routes can be done quicker and more cheaply by airplane photography than by any other known method. This is largely due to the circumstance that cameras have been hitherto considered as instruments of mere detail in the airplane industry as a whole, while as a matter of fact they will probably become one of the most important factors in the development of commercial aviation.

The most fruitful field of commercial work for the airplane camera in the United States will undoubtedly be the completion of the topographic survey of this country, which work includes the complete detailing of maps not yet complete, as well as the mapping of territories which till now has not been charted at all.

To this already extensive program should be added the locating of the high and low water lines along our coasts, besides work of more local interest, such as the production of correct maps of smaller communities for real estate records, the location of sites for dams for irrigation purposes, locating railroads and waterways through mountainous country, establishing aerial routes and emergency landings in vast wooded tracts, etc., all of which work can be done in a fraction of the time and hence for a fraction of the cost entailed by a complete manual survey.

It should, however, not be understood that the airplane camera renders manual surveying obsolete. On the contrary it is recognized that the camera is one the most effective work in connection with the slower but extremely accurate work of the surveyor, each one being checked up by the work of the other. In fact, it may be stated that the camera furnishes the filling-in details to a degree of perfection not attainable, or at any rate not obtained by manual survey, whereas the latter produces a series of exact points of location which serve as control points for the data furnished by the camera.

To obtain useful commercial mapping results from an airplane requires different methods of operation than those used to make the so-called mosaics, because maps will be made between control points often many miles apart, between which it will be necessary to fill in not only the general ground plan but also the contour lines.

As a matter of fact, the mapping use of airplane photography has been to a certain extent set back by the war, for the reason that certain scientific views, which are not relevant to commercial photography rather held the foreground, these were questions of emulsions and lens-openings, neither of which are really of as much importance as the purely mechanical sides of the problem.

Since all work enumerated before in this article is strictly of the order of map-making, only such photographic apparatus as is adapted to this class of work need here be noted. This excludes all hand-held or hand-operated cameras as well as any semi-automatic or non-automatic instruments which are rigidly attached to the airplane, since they partake with it in all its deviations from a perfectly horizontal position while in flight, a condition which is entirely incompatible with results for map making. This leaves thus the freely suspended type of aerial camera for further consideration.

The military use of the airplane camera during the war has led to developments which do not necessarily form correct precedents, because of the assumption that an observer is essential. This has led to undue emphasis being placed on hand operated or semi-automatic cameras, which were to be of such simplified construction that no imperfect functioning would occur under the hands of the operator-observer. These military conditions do not prevail, nor apply, in commercial airplane-mapping.

A division of opinion has existed relative to the automatic functions of airplane cameras among the Allied Governments, but in no case were there differences caused by the requirements of aerial photographic mapping.

Airplane Photograph Showing Bombed Area

British Official Photograph

Paramount importance was attached to the element side of aerial photography, much attention being devoted in particular to the perfection of color sensitive emulsions, to more readily detect camouflaged objects from the real ones.

No doubt this aim is worth while, but unless existing emulsions used with suitable ray filters were apt to produce, under the rough and ready conditions of actual field photography behind the lines, similar if not better results, with a far greater degree of likelihood to get any results at all, it must be regretted that those efforts placed the much more important mechanical side of the problem entirely in the shadow.

As long as the question of airplane photographs was a question of filling in maps with nearby control points the detail design of the camera was not of the highest importance. To take a series of views over well known ground is a problem comparatively simple, but commercial applications of airplane photography require more definite information in regard to drainage, divides and general contour information, as otherwise the main benefits of rapid surveying cannot be obtained. Photographic airplane surveying will unquestionably be used largely as a supplement of the Photo-theodolite and other more common methods of surveying, to fill in between control points established by the older methods. But in the case of the more or less unknown country between control points established by the more common methods, and for such works as coast surveying, arises the greatest need of airplane survey.

Surveying to be done from an airplane, particularly for filling in large areas, must be obtained by means of an automatic camera. On considering the problem of commercial airplane photography it will soon be possible to pick out the necessary elements of design, and why an automatic camera should be used.

All photographs to be used in map making must be a true horizontal projection of the earth's surface. In this way all points are practically reproduced by the photograph on a scale which is equal to elevation divided by focal length of the lense. If the plane of the photograph is not approximately parallel to the plane of the earth's surface (not considering the curvature of the earth) positions will not be correctly rendered, there is distortion in location which is equal to the cosine of the angle of inclination. In actual military practice, however, any camera installation which fastens the camera to the plane so that in the average flying position the camera is approximately horizontal was considered sufficiently good for purposes of making mosaics.

However, this is by no means an answer to the question of obtaining survey information, as in the case of obtaining contours from airplane photographs these can only be had by making use of the lens axis of the camera. The only way of establishing a true parallel position of the negative to the assumed plane of the earth is by means of the vertical position of the axis of the lens. Moreover, the only known factor for determining contours needed is the angular relation of the axis of the lens and its true focal length. With these two known factors the position of the earth can be graphically reproduced, and by ordinary drawing instruments a series of exposure points in the air can be determined. These exposure points are then used by transference of angles to reproduce graphically the location of points on the ground in space above or below the base line, which is usually taken at the foot of one of the nadir points of the series of photographs.

To obtain a vertical position of the axis of the lens necessitates a free suspension of the camera in the body of the airplane where it is not affected by the air current in motion. This is easily done by putting the camera in the Gimbal suspension similar to a ship's compass. However, it is necessary to maintain a constant position, as otherwise the variation in the rate of motion of the airplane through the air would introduce a pendulum action in the camera. There are only two ways whereby this can be done, first, by use of a gyroscope, and secondly, the use of gravity and suitable cushions to prevent oscillation, but at the same time allow motion relative to the swinging plane. In practice the latter method is the better, as it introduces no mechanical complications, and the accuracy resulting is close enough for mapping purposes.

In addition to the requirements of angular position, airplane photographic surveying requires a large number of photographs in a single flight. It is next to impossible to change plate magazines or to fill holders in flight sufficiently rapidly to obtain an unbroken series; moreover, it is necessary that photographs should be taken at what is practically a constant interval between exposures; if not, there is very apt to be a break between two successive exposures, which requires an additional flight to obtain the necessary information with which to fill the gap.

In a military sense, during the recent war, this matter was not of such importance as it becomes for photographic surveying, for the reason that usually photographs were taken of a single spot only, and intervening places were not necessary, although at times desirable. This has led to the use of film cameras using roll film having as many as 100 exposures to each loading.

The principal difference between different makes of cameras for purposes of making military mosaics are usually matters of obtaining necessary power to change plates or film negatives. Three methods of obtaining power have been used: the air fan, electricity, and spring motors.

In considering the design features of the camera it is very necessary to know to what extent photographic surveying will be carried out. If military mosaics are required, which generally are used simply to fill in small areas, a semi-automatic, regardless of form of drive, or even a hand operated camera may be useful. If contour surveying is to be done it becomes necessary to have a very accurate timing device for the interval between exposures, as otherwise the overlapping relations between exposures will very easily be lost. The European continent is so thoroughly surveyed that the contour method has been very little used, and in the considerations of the necessary types of cameras, contour mapping has not been considered an essential feature. For this reason the so-called automatic or semi-automatic camera ordinarily in use is not completely automatic but simply is a power driven mechanism which changes a plate or film negative and in which the actual exposure is made either by the pilot or observer. There is only one completely automatic camera in existence which operates at varying rates of speed, controlled with certainty either by the pilot or the observer. This is the Brock camera, which will be described later in detail.

When making flights for map-making purposes a given area of ground can only be fully covered if a number of flights in parallel courses are undertaken, each one flight following a course just overlapping the strip of land covered in the previous flight. The number of flights required to cover a given width of territory will then be directly proportional to the width of the strip embraced by the photographs, and consequently it is desirable to embrace as wide a strip of land as practicable in each view.

This consideration has led to the construction of triple lens cameras, the central lens pointing straight downward, and the lens on either side placed more or less outwardly slanting. These three lenses are in one vertical plane at right angles to the direction of flight. The image planes of the outer negatives are then usually set at an angle of 45 deg. to the central lens. These cameras are arranged to take simultaneously three exposures, one downward and one at each side of the flight, whereas the central lens registers the strip directly beneath the airplane and immediately adjoining regions.

Although this arrangement undoubtedly covers a width of territory not obtainable with a single lens, it introduces difficulties which seem to far outweigh its possible advantages, not the least of which is the inability to produce contour maps from the oblique views, except on fairly flat ground. The complications arising from three different planes of projection, and the necessity of afterwards reducing the two outer planes to that of the central one, without definite knowledge of the actual position of either plane at the instant of exposure, constitute insurmountable obstacles to the usefulness and commercial adaptation of devices of this kind.

It seems now preferable to obtain increased width of the strip of land depicted on the photograph by increasing the width and reducing the focal length of the lens, both to such limits as usual photographic and optical practice allow. A camera arranged to take negatives 5 x 7 in., the 5 in. side in the line of flight, and equipped with a lens of 8 in. equivalent focus, embraces at 5000 ft. elevation on each picture a strip of land 4375 ft. wide and 3125 ft. long in the direction of flight. At 7500 ft., or if elevated to 10000 ft. would produce pictures on a scale of 1:10,000, embracing 8844 ft. in width by 4100 in length. Most of the high grade lenses of 8 in. focus and openings of F 5.6 will cut a 5 x 7 in. image sharp and without distortion and are serviceable for such work.

The succeeding exposures should be timed at intervals of distance depending on the elevation and corresponding length of ground taken in the picture. The speed of the flight translates this distance interval into a corresponding time interval. It is thus desirable to provide means by which the actual time interval can be varied according to these conditions and which will operate with dependable precision in the various adjustments.

As the manufacturers of the Brock Automatic Camera it is probable that our actual experimental work in photographic surveying and in the design of cameras to obtain these results has been further advanced than the experimental work on this line by any individuals or by any of the Governments who have participated in the European war. The system of installation which we use has been found to permit exposures at from two to five times the exposure possible with any other system of installation, with all its attendant benefits. No other camera has been successfully built with a system of free suspension, with the result also, that no other camera has been built which can also do contour surveying. The importance of contour surveying in a military sense was becoming recognized as the war drew to a close, and consequently this field of endeavor has had but a fraction of the effort put on it which will be devoted to it in the next few years.

Another feature of camera design which originated with the Brock camera was the use of film for military purposes. The Brock film camera has been made successfully to use film in two sizes: one 4 x 5 in. using ordinarily a 12 in. lens, and one 8 x 10 in. using a 24 in. lens, both types completely automatic. These cameras were the first ones used which entirely eliminated static electricity in the film, and are today the only ones in which static electricity never occurs. The system of obtaining large negatives on film without distortion through the use of a glass support originated with the Brock 8 x 10 in. camera. However, the use of the large negative sizes will be confined to military purposes, as for commercial or ordinary Government mapping a very large scale is not required.

Let us now consider some of the mechanical details of the Brock 4 x 5 in. camera and the reasons for the design. This camera is the outgrowth of a series of experiments to obtain a free suspension camera, motor driven, within reasonable weight, certain of operation, and controlled from a distant point, for use in a single seated airplane.

Mechanical experiments led us into the design of the spring motor driven cameras and resulted in our finding commercially feasible means of controlling the speed of operation of the spring motor not in any way dependent on friction. The entire engineering profession is aware of the difficulty of obtaining a satisfactory variable speed friction drive which includes both certainty of operation and certainty of speed. In the case of a spring motor this difficulty is emphasized because the control through friction must be done by the introduction of a governor. Such a construction results in absolute loss of control of speed regulation owing partly to the different percentage of friction due to changes in the air or varying amounts. The system we use therefore is the control of the main spring motor by means of an auxiliary spring motor, which is in effect a check with a speed variation of 1½ to 1. The importance of accurate speed control in the case of the Brock camera is greater than in any other camera because of the fact that in order to produce contour maps it becomes necessary to obtain contours the axial point of the succeeding and the preceding negative must show on each exposure with the result that exposures must occur at frequent and constant intervals without interruption; otherwise a break in the sequence will partially destroy the value of the contour photographic flight.

Without any exceptions worth mentioning all aerial cameras are fitted with focal plane shutters, as the high efficiency of this type of shutter, together with its extreme mechanical simplicity, renders it superior to the in-between-lens shutter. In the Brock camera the focal plane shutter is provided with a fixed slot, the speed adjustment being obtained entirely by means of the spring tension. Speeds are variable from 1/50 to 1/200 of a second or any similar range.

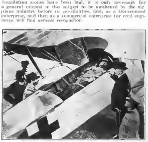
In connection with shutter speeds of airplane cameras it is of particular interest to mention that owing to the almost complete absence of vibration obtained with the gimbal suspension, shutter speeds can be regulated entirely with regard to the consumption of image movement through traveling speed and no regard need be paid to the effects of vibration. The requirements due to speed are very easily met. For instance, a camera as already mentioned fitted with an 8 in. lens flying at 5000 ft. elevation and at 120 m. p. h. requires no faster exposure than 1/20 of a second to give a sharpness corresponding to a circle of confusion of 1/4 1000 of an inch and with a speed of 1/50 of a second the circle of confusion will be only 5/6 1000 of an inch. This means that the gimbal suspension camera has the practical advantage of being able to photograph both earlier and later in the day than would be practical with rigidly suspended cameras which are generally used with minimum exposures of 1/100 of a second to eliminate as much as possible the effects of vibration. It also means that such focal plane shutters can be made with wide slots to reduce the duration of the exposure period, and thereby the resulting distortion to a perfectly negligible minimum, which in turn eliminates the main seemingly valid arguments against focal plane shutters.

A perfect evenness of exposure at all speeds can easily be obtained by proper design of the focal plane shutter, in fact so that the slightest difference in exposure plainly seen on airplane films, since maximum and minimum density adjoin in two negatives of a strip of continuous pictures side by side, will show no observable variation. Especially in civil or commercial uses of airplane photography do these various features come to their fullest significance, and it is only on this account that they have been mentioned in detail.

Summarizing, the status and development of airplane photographic surveying is as yet still in its infancy. Unless the aeronautical trade recognizes the possibilities of this use of their product, and unless the engineering profession of the business realizes its possibilities it is not likely that the growth will be rapid. It is an unfortunate fact that up to the present time the energy devoted to the constructive surveying features of airplane photography has been confined to, and understood by, only a few people.

The truth of the matter is that in the first place the emulsion questions which have arisen in Europe are really matters of no serious consequence, although a considerable amount of time and effort has been spent to change and to make special emulsions. Efforts have also been made in Europe to make emulsions sensitive to certain colors, whereas similar if not better effects could have been obtained with existing emulsions by the use of a color screen and lengthened exposures. Whatever efforts have been made in the mechanical direction, they have been very largely in the direction of making a camera which could be operated by the average observer without any knowledge of photography or of mechanics. It is safe to say that if the motion picture industry which is now in existence had had a military use and military development, the present stage of perfection would never have been reached, as the commercial side of the motion picture industry has received a tremendous amount of attention for years. High class motion pictures cannot be made by any one but a skilled operator, and in exactly the same way the success of the future of airplane surveying is dependent upon operators learning about the necessary photography and mechanics of airplane cameras, but it must be recognized for the future of airplane surveying that apart from the development of the negative and the printing of the prints, airplane photography is a matter which should be entirely in the hands of civil and mechanical engineers.

The modern airplane has reached the stage of development where the safety of operation and the certainty of operation is as good as of the average automobile of ten years ago. This means that an airplane can be used to fly for some hours over entirely unknown country without any landing places, it further means that such country can be completely and correctly mapped without difficulty and at a very low expense compared to the present day methods of surveying. It is quite possible that in the future preliminary surveys will be made for railroads, roads and various water works entirely by airplane photography, and that when the line has been decided upon a party will go out simply for the purpose of staking the proposed lines. If the airplane industry will devote as much attention to this subject as has been devoted to other commercial possibilities, a rapid growth can be expected. As foundation stones have been laid, it is only necessary for a general interest in this subject to be awakened by the airplane industry before its possibilities, first, as a Government enterprise, and then as a commercial enterprise for civil engineers, will find general recognition.



French Airplane Ambulance

British Official *Feature Photo Service*

News of the Fortnight

Major Gen. Menoher, Director of A. S.

Major Gen Charles T. Menoher has been appointed Director of Air Service in place of John D Ryan, resigned The appointment was announced by the War Department on December 21 In making the announcement for the Department, the Chief of Staff said

"The resignation of Mr John D Ryan and Mr William C Potter from the Air Service has brought about the consideration of putting permanent military officers in charge of those facilities, and during the week I have designated Col James A Mars as Acting Director of Aircraft Production, to relieve Mr Potter, and have designated Major Gen Charles T Menoher as Director of Air Service"

General Menoher is a native of Pennsylvania and was born on March 20, 1862. He was appointed to a cadetship at West Point on July 1, 1884, and upon graduation four years later was a second lieutenant in the First Artillery, from which he was transferred to the Third Artillery on December 23, 1893 He was then a first lieutenant On March 8, 1898 he was transferred to the Sixth Artillery, and was appointed a captain in the Artillery Corps on February 2, 1901 He was given his majority on January 25, 1907, and on June 6 following was assigned to the First Field Artillery His promotion to a lieutenant colonelcy came on May 26, 1911, and on September 8 1914, he was assigned to the Third Field Artillery

General Menoher was a member of the General Staff from August 15, 1903, to March 21, 1907 and is also a graduate of the Artillery School (1894) In 1907 he was in the Army War College. As commander of the Forty-second Division (Rainbow) General Menoher was one of the first Army officers to go to France after the United States entered the war His record as division commander during the active fighting led directly to his promotion to his present rank and assignment to the command of the Sixth Army Corps, with which his old division was consolidated, some time prior to the signing of the armistice His old division is now attached to the American Army of Occupation on the Rhine, but General Menoher is under orders to return home and is now on his way to this country to take up the duties of his new post

A. S. Peace Plans Organization

A board on peace plans organization has been appointed by the Director of Military Aeronautics to work out the peace time organization for the Army Air Service The personnel of the main board and sub-boards is as follows

Board of Organization Col C G Edgar, Col F R Kenney, Col Arthur Woods, and Major E Hubert Litchfield, Recorder

Operating under this board are the following named sub-boards

Demobilization of the Department of Military Aeronautics Lt-Col James A Mars, Chairman, Lt-Col Rush B Lincoln, Lt-Col Geo B Hunter, and Maj Walter G Rogers.

Air Service Operations in Peace Times Col William E Gillmore, Chairman, Col Gerard C Brandt, Lt-Col Thomas Duncan (Pacific Coast), Lt-Col Barton K. Yount (Mexican Border), Lt-Col. Ira Longanecker (Atlantic Coast) Lt-Col Benjamin F Castle (Interior), and Capt John W Davis

Mustering Out Maj E Hubert Litchfield, Chairman, and Lieut J J O'Brien

Training Col Milton F Davis, Chairman, Lt-Col. John A Drexel, Lt-Col Seth W Cook, Maj William A Robertson and Prof. Edward L. Thorndike

Inventions and Research Capt Adelbert Ames, Jr, Chairman, Capt. Robert R McMath and Prof Wallace C Sabin

Supplies Lt Col Thomas G Gallagher, Chairman, Lt Col Harold Benington, Maj Curean S Benton, Maj Walter G Rogers, Maj Eugene Deacon, Maj Harold R Eyrich and Capt David R Wheeler.

Examined 4,000 Aircraft Inventions

From July, 1915, to July, 1918, the British Board of Invention and Research received and examined 53,000 war inventions and proposals, of which about 4000 related to aircraft

International Aircraft Exposition

Far greater than any aeronautical exhibition ever given in America will be the International Aircraft Exposition to be held in Madison Square Garden, New York City, from February 27 to March 6, both dates inclusive

It will tell the story of "The Future of Aeronautics in America"

All kinds of aircraft used in the world war will be shown, while many new types designed for commercial purposes and for which military machines are utterly unsuited, will be displayed and described to the public

Official announcement of the plans will be made at a dinner to be given at the Waldorf Astoria, on Tuesday, January 7, at which 500 persons identified with aeronautics in various capacities will be present Arrangements for this dinner are being made by J G White, of the J G White Engineering Co and President of the Springfield Aircraft Corporation

Bids Asked for Equipment

The Salvage Branch of the Supply Section of the Department of Military Aeronautics has invited sealed bids for the following material

1 1,000 Standard J-1 airplanes equipped with Curtiss OX5 90 engines, at Houston, Tex

2 200 Standard J-1 airplanes with Hispano Suiza 150 hp engines, at Houston Tex

3 Standard J-1 airplanes, without engines, Houston, Tex

4 10 L. W F airplanes, with Thomas 135 hp engines, at St. Paul, Minn

5. 2,000 A 7 A four-cylinder Hall-Scott engines, at Houston, Tex

The bids for the above materials will be opened at 11 A M on February 1, 1919, at the office of the Salvage Branch, Washington, D C Each bid must be submitted in duplicate and accompanied by a certified check for 20 per cent of the amount of the bid The Government will receive proposals for any item or any quantity subject to the usual reservations. The terms of all sales will be cash, f o b location given, and delivery must be made within ninety days.

Curtiss Airplane Line

It will be possible to make daily trips to Atlantic City from New York next spring—and the service may be extended down the coast to Newport News, Charleston and the fashionable resorts along the east coast of Florida

Announcement of this project is made by Glenn H Curtiss, president of the Curtiss Engineering Corp of Garden City, L. I

Flying boats to be used on this line are ready or nearly completed, and details of operation are now being worked out

In addition to passengers the Curtiss Airplane Line will carry small package freight, and a tariff for this business is in the course of preparations, as well as the rates for passengers.

The trip will be made in less than an hour, and very likely will enhance the popularity of the New Jersey resort among New Yorkers and visitors to the metropolis

Chicago Air Mail Jan 2

Following repeated unsuccessful attempts to transport the mail on the New York-Chicago route of the Aerial Mail Service, the officials decided to postpone further efforts until January 2, when, they give the assurance, the service will be regularly operated. This statement, together with an explanation as to the cause of the failure of the service to function properly as planned, was made in an announcement issued by the Post Office Department on December 21

To Save Liberty Engine Machinery

While the big American aircraft program has been stopped and officials and experts are engaged in undoing contracts covering hundreds of millions of dollars, arrangements are being made to preserve the machinery which made possible the manufacture of Liberty engines in large numbers and other successful war material

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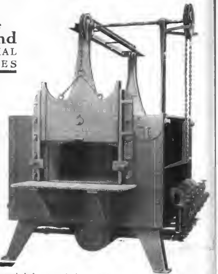

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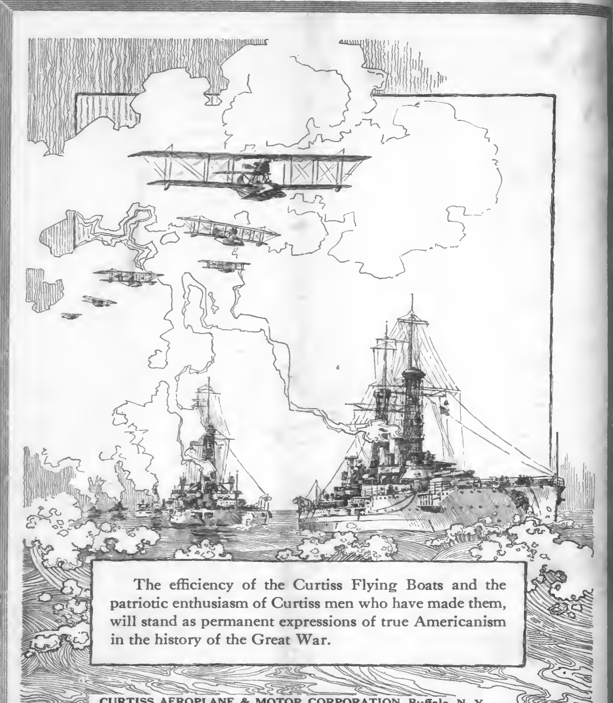
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